VOLUME LXIII NUMBER 1

INDIAN FORESTER

JANUARY, 1937

FROST IN THE CENTRAL PROVINCES

By C. M. Harlow, I.F.S.

Summary—The note gives details of the frosts which have damaged the teak forests of the Western Circle of the Central Provinces and Berar in recent years. Records of earli.r frosts are also given Attention is drawn to the apparent fact that frosts earlier than January do less damage than later frosts : the period of great danger seems to be after about the 10th January. Minimum temperatures recorded at Khandwa over a series of years are then examined and an attempt made to correlate them with the years in which serious frost damage has been known to occur. One aspect of the effect of such frosts on the normal forest undercurrent methods of management is then given.

This note is the result of observations during the past two years in certain forests in the Western Circle of the Central Provinces and applies to them only. It mainly concerns the Hoshangabad and Nimar divisions, but to some extent the Melghat and Betul; in all these divisions teak is the principal species. Until about 1927 the management seldom prescribed heavy fellings and attempts at regeneration were rare. The effects of frost have been recorded in annual reports from time to time, but no very great importance was attached to injury from it and the statement has been made that frost never occurred in Nimar. It was generally recognized that frost is a danger at the bottom of the steep narrow valleys of the Satpuras, and it seems to have been assumed that otherwise there was little danger from this source. With some quite definite exceptions the references to frost damage in annual and other reports are of doubtful value and attempts to correlate them with actual records of frost conditions may not lead very far. After 1927 the system of conversion of the forests to uniform by successive regeneration fellings was introduced in Betul division and gradually extended to the others. By 1936, nine, eight, four and nought coupes in each felling series had been subjected to such fellings in Betul, Hoshangabad, Nimar and the Melghat. At first all went well but in February 1929 there was a serious frost from which regenerated forests at the bottom of narrow valleys in Hoshangabad and Betul suffered; the areas affected were quite limited, the damage was anticipated and no great

importance need be attached to it. At the same time, however, in Hoshangabad, fairly extensive areas of flat land lying on both sides of main rivers where they debouched from the hills suffered and as some of these areas had recently been regenerated the damage done was severe. In such coupes the whole of the reproduction was cut back to ground level and though teak was able to recover there is some doubt even now about the miscellaneous species. It was also noticeable in Hoshangabad that a small increase in the height of ground had in some cases enabled the young crop to survive the frost. This severe frost was regarded as something most unusual in Hoshangabad and no very great attention was paid to it, especially as regenerated coupes were only one year old. I was myself touring at the time in the forests of Nimar along the Nerbadda. Damage was only too obvious both in the forest and in the fields of wheat, gram and *tur* (*Cajanus indicus*). The forests were mainly under improvement fellings, coppice shoots were certainly cut back, but the damage though clearly severe was not a disaster in any place. The local people said that such frost damage in their fields was quite unknown to them, and my own impression at the time was that so cold a spell in "frost-free Nimar" was a freak of nature. There was no great frost damage in Betul, but there certainly was damage to standing trees in the deep narrow valleys of the Melghat, where the smaller trees suffered in the crown, and the misshapen crowns can be readily recognised to-day. Here, again, no great damage was done to young trees, because they were neither numerous nor concentrated; the damage to the bigger trees did not affect the timber in them to any obvious extent: and no action was taken except to record the severity of the frost. In the Melghat there are many well-known frost holes, especially where the valleys widen out, and these areas are usually regarded as almost unproductive because they are frequently badly frosted in years when no frost effects are recorded anywhere else except in much less numerous though quite similar frost holes in Betul and Hoshangabad. All went well for the next four years and regeneration began in Nimar. The teak in the damaged coupes of Hoshangabad recovered and the forest officers were rather pleased

with the results of their experimental regeneration operations on rather a large scale. Then occurred another serious frost in January 1934, which affected much the same felling series as the 1929 frost had done. Many coupes 1 of Nimar had been clear-felled under the new plan and were one year old. In two felling series, Balwara (Punasa) and Machak (Chandgarh), practically the whole coupe was frosted ; in a few other felling series, low-lying parts only were frosted. In Betul division the better forests in the north escaped any serious damage, and only quite small patches in obvious frost holes suffered at all ; the poorer forests in the Tapti valley seem to have suffered more but I have not seen them since. The Melghat suffered the same damage as in 1929 but on a smaller scale. This frost so soon after that of 1929 made the forest officers realize that they were up against something fairly serious. Large-scale experiments involving considerable change of method were introduced. The methods of regeneration prescribed in all Working Plans followed the same lines, and wherever reproduction was good regeneration was by clear fellings ; regeneration by seedling and coppice is on the whole very good in these forests, so that large areas of all coupes had been clear-felled. In an experiment in Uskalli felling series of Hoshangabad coupe 8 was felled in strips. In other felling series only clearly safe areas were clear-felled and the rest treated by removal of the bigger teak, opening up of little groups of seedling reproduction and fairly general retention of miscellaneous species. There was a certain amount of panic and such careful operations were carried out in places where it was wholly unnecessary : for it must be understood that at the worst only in a fraction of the number of important felling series both in Nimar and Hoshangabad have large areas been damaged. There was still more inclination to panic when yet another severe frost was experienced in January 1935, affecting, however, almost exactly the same felling series as before.

It now appeared high time that some enquiry into the whole question should be made. I had had experience of the 1929 frost but was posted in a frost-free division during the frosts of 1934 and 1935. However, in March 1935, I joined this circle and the importance of

the frost question was impressed on me. I toured in the east of Hoshangabad in April of that year, but the more important frost-affected felling series lie in the west. The two worst affected felling series in the east are mainly miscellaneous species where work had already been abandoned or nearly so as the revenue from them was poor. In the more important felling series small patches of regenerated areas had suffered. The effects of the 1929 frost could not be seen usually in the young coupes as much departmental cutting back had been done. The effects of the 1934 and 1935 frosts were quite clear. As seedlings are always cut back in regeneration operations on account of invariable bad form, all reproduction is really coppice. In the bad frost holes all shoots were frosted back to the ground, in both years. In Kakri felling series I found all stages of damage on the edge of the frost holes and it showed some vagaries. Patches which had suffered in 1934 had escaped in 1935, and adjoining within a few yards would be shoots untouched in 1934 but damaged in 1935. In such cases the damage generally affected only the top foot or so of the stem but it was rather a puzzle. In this felling series the valleys are not very well defined and the country is rather of a rolling undulating type. From my subsequent observations I am inclined to think that this vagary is explainable especially as it is found also in frost-damaged fields on rolling country. The periods of low temperature occur when there is no great general movement apparent in the air, in fact frosty nights are fairly still. There are, however, definite movements of the air and even a small current can hold up the descending currents of cold air, causing it to pile up and thus cause frost damage. In well-defined country these air currents will follow the valleys one way or the other and any frost damage that may occur is likely to affect the same spots. In more undulating country these air currents may be expected to follow a less general course and the cold currents are liable to be held up at more varying spots.

The cold weather of 1935-36 was a mild one and there seems to have been no frost damage except in the really bad frost holes. I was able to tour through the worst damaged parts of Hoshangabad and Nimar, in the better forests of Betul and also in the Melghat.

The damage done in the previous year was everywhere clear to the eye and that of 1934 equally so except, of course, where cutting back of damaged stems had taken place. Damage had occurred in many felling series but in the hillier parts it was confined to the lowest ground and to definite areas of small size, so that no great amount of importance need be attached to it. The areas in Hoshangabad damaged badly have already been described as the flat lands where the main rivers debouch from the hills. There are three such big tributaries of the Nerbadda. There is little such flat land where the Moran leaves the forests and so there is not much damage. On the Machak there are large areas of this type of land and on the Ganjal very large areas. Many such areas had been clear-felled for regeneration and in every case, with the exception of higher lying patches, everything had been frosted back to the ground by frosts of 1934 and again of 1935. Teak is hardy and has coppiced again. Miscellaneous species are only a small proportion of the crop; my impression was that a large proportion was killed but not having seen the forests before for many years I may be mistaken. One felling series on the Ganjal, Amakatara, is largely situated on low ground, and I found that large areas of unregenerated forest are nearly pure teak of unusually bad form, showing clear evidence that the crowns had suffered severe damage from frost in many recent years. Such areas can never be of much value as forest. Fortunately this was the only such case I saw in this part of Hoshangabad, but it does not follow that others do not exist. The recovery of young teak from severe damage by frost in two successive years is remarkable. Frost merely coppices it and I doubt if very many individuals are completely killed. Given a series of frost-free years, I see no reason why such frosted areas should not grow up into a forest again. An experiment had been made in Uskalli felling series Coupe 8 by felling in alternate strips only: the strips are 40 feet wide and run north to south. Alternate strips of this width were left untouched and in the others only teak was felled: miscellaneous species, however, were few. The leaf-fall here takes place in early January so that in no case would the retained strips give much protection from the sun in

the dangerous period of January and early February. Other experiments had been made elsewhere by retaining all miscellaneous species and all teak below about two feet in girth. This will ensure a crop of some sort on the ground, but clearly we are not regenerating the forest as prescribed ; so far no alternative presents itself. It may be bad silviculture for teak but until we know more about frost, I can see no system which will not endanger the existence of such forests as frost.

In Nimar widespread frost has been experienced in the forests lying on both banks of the Nerbadda but the worst is certainly on the south bank and it is here that I spent most of my time. The damage done is severer in two felling series, Balwara (Punasa Range) and Machak (Chandgarh Range), but a number more are affected. Near Balwara, the bank of the river is formed by a low range of hills some hundred feet or so high. The drainage runs to the north and the main tributaries cut through these hills. South of the hills the country falls away often fairly gently for about three miles when an open cultivated black soil plain is reached. The intervening country is Balwara felling series. The ground is gently undulating but there are flat patches of shallow black soil of many acres especially on both banks of *nalas*, and it is on these soils that the best teak forest is found : the type of forest is much the same as in the frost-damaged flats in Hoshangabad. This felling series and the adjoining forests have been heavily worked for years, mostly by improvement felling series, but from 1932-33 the Balwara felling series main fellings have been practically clear fellings for regeneration. Coupe 1 was one year old when it was frosted back by the 1934 frost. Coupes 1 and 2 were both exposed to the 1935 frost and both were almost completely cut back by it. There was a curious fact in coupe 1. A few acres, the lowest lying in the coupe and along the *nala* forming its boundary, were left untouched in fellings because the stocking was only about ·4 and reproduction poor. The standing trees were damaged by frost in the crowns but in no case severely. On the other side of this *nala* is the same general type of forest as coupe 1, and it was thinned, partly before the frost of 1935 and the rest after the 1935 frost. Thinnings in each case had opened the forest up heavily, say to ·7

density. The part thinned early had suffered very severely from frost. My notes read that there has been much damage which has affected the tops of trees even fifty feet high : sometimes only the tips of trees but sometimes whole crowns have been killed. Some trees, even small ones, have escaped altogether for no apparent reason. The presence or absence of big crowned miscellaneous species seemed to have no influence and I could see no rhyme or reason for the way in which the frost has acted. A badly frosted big teak tree may adjoin a smaller one that has escaped. Some whole patches have escaped for no obvious reason. The crop thinned after the 1935 frost had also suffered but not so badly. I then inspected all the forest in this valley, and it is a teak forest, say fifty feet high and generally very dense. Frost damage is inconspicuous but clearly there if looked for. Generally only the tips of the trees are touched and there is seldom damage to whole crowns. I thought I could trace damage of the three recent frosts of 1929, 1934 and 1935. I inspected large areas in the vicinity and there is no doubt that any recent felling, even a thinning, lets in the frost. Another curious fact that seems to emerge is that forest that has been untouched for a number of years, even an open crop such as that remaining in coupe I, seems to be able to resist the attack of frost much better than a recently thinned crop. A fact noticed which may have some bearing on the frost question is that in these types the standing crops of teak have lost most of their leaves by the middle of January, but the young crops of one and two years still carry the bulk of their leaves. The damage done in the Machak felling series is nearly as bad as in Balwara. Some large areas had been felled over here by heavy improvement fellings shortly before the present working plan was introduced. All such areas on the low ground have suffered heavily. There was no damage whatever along the banks of the Nerbadda.

In my wanderings round these forests I found one bad frost hole in Balwara and near its edge, I might even say adjoining its edge, was a little group of about a dozen teak poles of say 50 to 60 feet high, all with perfect boles or nearly so. The crowns of each tree showed evidence of each of our three recent frosts, and without doubt

each crown had suffered from each frost of 1929, 1934 and 1935. It seems fair to argue that during the 40 odd years of the life of these trees, while the boles were growing, there had been no frost serious enough to do any but slight crown damage ; otherwise one or two of the boles would have shown some sort of deformity.

At this stage I record my impressions that I received from inspections.—

(*i*) This tract grows wheat, *tur* and gram, all suffering from bad frost. These crops were damaged by frost in 1929, 1934 and 1935. The local people hardly remember such frosts previous to 1929 but I did get some information of a light frost about 1916.

(*ii*) The effects of severe frosts persist on teak trees throughout their lives and the damage done by the 1929 frost is clearly to be seen seven years later. Ignoring frost holes no badly shaped crops are to be seen anywhere except the case of Amakatara felling series in Hoshangabad.

(*iii*) Forest officers have a tradition of frost damage at the bottoms of valleys in the hills. There is no such tradition in the flat areas which I have described as the bad sufferers now.

I tried to find out at what period of the day the actual damage by frost occurs. One has learnt that damage is caused not by the frost but by the subsequent thaw in the warm sun of the early morning. It certainly is a fact that at the dawn no damage is obvious and frosted young teaks are covered with rime, but the leaves are green. As the sun gets higher the leaves quickly turn brown. This is not adequate proof that the rupturing of the cells took place at the thaw and not at the onset of the frost. The local people, however, told me that they could sometimes save *tur* crops in a field by dragging a rope across the crop to remove the rime from the plants before it melted ; this is at least interesting but I had no chance to test it. The same people also said that a heavy dew and a wind are always present when frost damage is severe in their fields.

With the idea of trying to find out something more on the subject, I asked the Director-General of Observatories for figures of minimum temperatures as recorded at Hoshangabad and Khandwa. He supplied the figures from 1876, together with other useful information for which I had not asked. Hoshangabad is situated far from forests and on the bank of the Nerbadda; temperatures below 40° F have rarely been recorded. I have not made any use of the Hoshangabad figures and what follows applies to Khandwa figures only. Minimum temperatures are recorded under certain standard conditions and it does not follow that there is no frost unless 32° F is recorded. The criterion adopted by the Indian Meteorological Department for frost conditions at ground level on exposed sites is that a minimum temperature of 40° F should be registered under the standard conditions used by that department, namely at a height of four feet from the ground by thermometers exposed freely in a standard shed or Stevenson screen. It is possible to test the applicability of this statement to wooded areas as we know that severe frost damage occurred in Nimar (Khandwa) forests in 1929, 1934 and 1935. Also it is known that a severe frost occurred in 1905. The following are the minimums recorded in Khandwa in these years:

1905 ..	36·7° on 8th February (4 days below 40°);
1929 ..	38·6° on 2nd January and 33·0° on 1st February (4 days below 40°).
	37·0° on 29th December (4 days below 40°);
1934 ..	35·0° on 13th January (6 days below 40°); and 37·0° on 1st February (2 days below 40°).
1935 ..	35·0° on 16th January (5 days below 40°).

This would seem to confirm the statement of the Director-General of Observatories.

The Forest Department has fairly reliable records that frost damage occurred in the above years. It now remains to see on what other days during the period 1905—35 minimum temperatures below

40° F have been recorded at Khandwa. They are—

1906	..	38·2° on 17th January (2 days below 40° F).
1908	..	38·1° on 28th December (1 day below 40° F).
1911	..	36·1° on 2nd February (1 day below 40° F).
1914	..	38·7° on 22nd December (2 days below 40° F).
1916	..	*35·1° on 8th February (1 day below 40° F).*
1922	..	37·6° on 27th December (2 days below 40° F).
1926	..	36·6° on 27th December (3 days below 40° F).

The annual reports have been examined for record of frost damage during these years. There are records in very meagre terms but I fancy they all refer to frost hole damage and not to flat area damage. In fact I must reject all this desirable information on account of lack of detail and standard of comparison. For example, reading these reports one would imagine that the worst frost occurred in 1910-11 which it certainly was not.

If it is a fact that severe frost damage has not occurred in the Punasa and Chandgarh forests between 1905 and 1929 one feels called upon to try to explain why it did not occur in the other years when temperatures were recorded at Khandwa similar to those recorded in the known bad frost years. The Director-General of Observatories has observed that " It is seen further that during the frosts of 1929, 1934, 1935 the minimum was below 40° F on a number of consecutive days; on such occasions the frost damage would naturally be much greater than if the minimum should fall below that value for a single day." One notices that in 1905, 1929, 1934, 1935 the minimum temperatures below 40° F lasted for 4, 4, 6 and 5 consecutive days. In 1908, 1911, 1916 the minimum below 40° F occurred on one day only, in 1906, 1914, 1922 on 2 days only and in 1926 on 3 days. This may explain why we got no serious frost damage in 1908, 1911, 1916 and possibly also in 1906, 1914 and 1922 but the three consecutive days below 40° F in 1926 appear to be somewhat anomalous. The only explanation I can suggest is that this frost occurred around 27th December. At this period the teak and many other trees in Punasa and Chandgarh still carry a fair crop of leaves which appear to confer a certain protection against cold (blanket-effect) whereas

in the latter half of January and early February the teak has lost a good proportion of its leaves. In this connection I may mention that there were 4 consecutive days below 40° around 29th December 1929, and as far as I know mild frost damage only was recorded in this season (1929-30).

One is inclined to think that the frost dangerous period in these forests is from about 10th January to 10th February which is also the period of the fall of the teak leaves in this locality. I have received the records of minimum temperatures at Khandwa over a period of 61 years (1875 to 1936). The following table shows the dates when minimums below 40° F. have been recorded and also the total number of days below 40° which are frequently but not always consecutive:

Year	January		February		November		December	
	Date	Number of days	Date	Number of days	Date	Number of days	Date	Number of days
1875	..	..	1	3	..	..	..	..
1878	3	2	..	..	..	..	22,23	3
1879	..	..	..	..	29	4	11	7
1883	..	..	..	..	..	..	18	6
1886	..	..	4	2	..	..	..	..
1887	..	..	9	2	..	..	..	..
1893	..	..	10	1	..	..	..	..
1897	..	..	..	..	..	..	18	1
1899	9	5	..	..	..	..	..	..
1900	25	1	..	..	..	..	..	..
1902	..	..	..	..	..	..	27	5
1905	..	..	8	4	..	..	..	..
1906	17	2	..	..	..	..	..	..
1908	..	..	..	..	..	..	28	1
1911	..	..	2	1	..	..	..	..
1914	..	..	..	..	..	..	22	2
1916	..	..	8	1	..	..	..	..
1922	..	..	..	..	..	..	27	2
1925	24	2	..	..	..	..	..	..
1926	..	..	..	..	..	..	27	3
1929	2	2	1	2 (4)	..	..	29	4
1934	13	6	1	2	..	..	..	..
1935	16	1	..	..	..	..	..	..

The minimums recorded in 1893, 1897, 1906, 1908, 1914, 1925 were only just below 40° and as the figure was recorded only on 1 or 2 consecutive days these were almost certainly not frost years. Similarly, bad frosts probably occurred in January-February 1875, 1899, 1905, 1929, 1934 and 1935 but in 1875 the minimum was only

38·7° at Khandwa on 1st February. In 1899, 1905, 1929, 1934, 1935 there must have been bad frost damage. So far as December is concerned there have been bad frost years in 1878, 1879, 1883, 1902, 1929 but it is uncertain whether any serious frost damage occurred to the standing tree forest on these occasions. I may mention, however, that in the Melghat a number of successful teak plantations were made in low-lying villages between 1870 and 1880 and that this work was abandoned on account of frost damage. It would appear that the December frosts of 1878, 1879 were probably the cause of this remark in our records and that these plantations grew up into the present fine woods they are, during the apparently frost-free years between 1883 and 1899. The height and density of the 20-30-year-old crops presumably enabled them to escape very serious damage from the severe frost of 1899.

The conclusions one would like to draw from these facts are as follows. Damage to standing crops of the forest has probably occurred in the past in the years of severe frosts between 10th January and 10th February, namely 1875, 1899, 1905, 1929, 1934, 1935, that is to say, at fairly infrequent intervals—six times in 63 years. This is true for crops of medium height or over, which appear to be naturally protected against the effects of severe December frosts. We cannot so assume that young regenerated coupes of small height growth will be able to withstand damage from December frost to anything like the same degree if at all and therefore damage to young plantations and young regenerated woods would have occurred in the seasons 1874-75 (2), 1877-78 (0), 1878-79 (4), 1883-84 (14), 1898-99 (3), 1902-03 (1), 1904-05 (21), 1926-27 (1), 1928-29 (0), 1929-30 (3), 1933-34 (0), 1934-35 (1), namely 12 times in 63 years. The figures in brackets show the number of frost-free years intervening between frost years.

If the badly frosted areas of Punasa and Chandgarh had been worked under the present Working Plan from 1876 we ought to have now (without frost damage) a forest consisting of 60 coupes of ages from 1 to 60 years. We should not have got this on account of frost. Coupes 1 to 7 would have been cut back by the frosts of 1878-79 and 1883-84 but would have grown beyond the danger of obliteration in

the 15 years up to 1898-99 and by 1936 would be 53 years old. About 8 of the coupes worked between 1883-84 to 1898-99 would have been big enough to survive the 1899 frost and about 7 would have been cut back. These together with the coupes worked between 1899 and 1905 would have been cut back in 1902 and 1905 and all these coupes—7 plus 5—would have grown into a forest from 1905 and would in 1936 have been 31 years old. During the frost-free 21 years—1905—27—about 14 coupes might survive the effects of the 1927 frost and 7 would be cut back and never get a hope of growing above the frost up to 1936. The position at the end of the Working Plan period ought to have been the normal series of coupes 1 to 60 years old. Instead we should have—

8 coupes	53 years old.			1 coupe	28 years old.		
1 coupe	52	,,		1 ,,	27	,,	
1 ,,	51	,,		1 ,,	26	,,	
1 ,,	50	,,		1 ,,	25	,,	
1 ,,	49	,,		1 ,,	24	,,	
1 ,,	48	,,		1 ,,	23	,,	
1 ,,	47	,,		1 ,,	22	,,	
1 ,,	46	,,		1 ,,	21	,,	
1 ,,	45	,,		1 ,,	20	,,	
14 coupes	31	,,		1 ,,	19	,,	
1 coupe	30	,,		1 ,,	18	,,	
1 ,,	29	,,		1 ,,	17	,,	

16 coupes 1 year old.

I have assumed above that coupes 8 years old can escape obliteration by severe frost. I do not know if this is true ; the only fact I do know is that the Jawardha coupes of Hoshangabad could not escape obliteration after 4 frost-free years.

It is not possible for us to say that because we have recently gone through a series of bad frost years, we are now in for a series of frost-free years. All we can say is that we have had in the past 60 years, three periods of bad frost separated by long periods, comparatively free from frost, and that a similar sequence will occur during the next 60 years. When we shall begin the next series free from frost

it is impossible to say until it has occurred. The question we have to ask ourselves is whether we shall be satisfied during the current rotation with a result such as that shown in the example given in the previous paragraph.

ADDITIONAL NOTE ON PLANTATION OF *DALBERGIA SISSOO* IN KEONJHAR STATE

H. F. MOONEY, I.F.S.,

Forest Adviser, Eastern States, Sambalpur

Having recently visited the *sissoo* plantation described in the *Indian Forester* for January 1936, I should like to add a few remarks about its progress in view of the scepticism that was expressed at the time regarding the figures of growth. The plantation is now over six years old, having been started in April 1930, and has proved so promising that it is proposed to take up further tracts of sandy waste both along the Baitarani river in Keonjhar State and in the riverain tracts of Baramba and Narsinghpur States along the Mahanadi. The local value of the plantation is appreciated by the villagers, who are not too well off as regards their supplies of timber and fuel; and requests have been made by them that the *sissoo* plantation should be extended in order to assist them, which is being done.

As regards measurements, the maximum individual height of the *sissoo* is 61 feet, the same specimen having a diameter of 9½ inches. The maximum diameter is now 10½ inches, the same tree having a height of 55 feet. The *average* height of the best areas (which constitute about 50 per cent. of the whole) is 45 feet and the diameter 6 inches. The average for the whole plantation, including some poor areas, is estimated to be between 35 and 40 feet. The increase in height between the 5th February and 14th August 1936 varied from six to nine feet by actual measurement. The heights are actual measurements made with graduated bamboos, so there is no error due to ocular estimates.

FIG. 1.—SIX-YEAR-OLD *Sissoo* PLANTATION, AVERAGE HEIGHT 33′

FIG. 2.—SIX-YEAR OLD *Casuarina equisetifolia*.
BEST STEM $62\frac{1}{2}'$ HIGH AND 8″ IN DIAMETER

Photos by H. F. Mooney.

An area now 4 years old gives some interesting figures. This area failed in the first instance due to an invasion of *tāndi* grass (*Saccharum spontaneum*). The grass was cut without effect and was ultimately uprooted (a difficult task). The *sissoo* plants were put out 6 feet × 6 feet and have now reached an average height of 33 feet, the highest being 38 feet with a diameter of 6½ inches. The closer spacing has resulted in the suppression of the *tāndi* grass which is now rapidly disappearing.

In the areas taken up in 1930 the spacing was 10 feet × 10 feet. Owing to the superlatively good growth of the *sissoo* the grass has already been completely suppressed over most of the area and its place taken by *Tridax procumbens*, L. and a few shade-bearing grasses. On the other hand, where the sand is deeper and the growth of *sissoo* has not been so rapid, there is still a dense growth of grass which will probably remain for some time. Future plantations will be spaced 6 feet × 6 feet.

In the note of January last, the general failure of *Casuarina* was ascribed to the depth of sand. This appears to be quite true where the depth is greater than 9 or 10 feet. Under these conditions neither the *sissoo* nor the *Casuarina* thrive, the plants being still mostly less than 3 feet high. Elsewhere, I think, the trouble has been the failure of the *Casuarina* to compete with the very rapid growth of the *sissoo*. The original intention of introducing the *Casuarina* was to clean the *sissoo* and to keep down grass. Generally speaking, it has disappeared. Only where small groups of pure *Casuarina* occur or where there are isolated individuals has this species succeeded. Where not interfered with by the *sissoo* it has done quite well, the best stem measuring 62½ feet high and 8 inches in diameter.

It is interesting to observe the species that have entered the plantation since work commenced. It must be borne in mind that the area was a barren, sandy waste in 1930, completely devoid of vegetation except for a few clumps of *Saccharum spontaneum*, which was beginning to make its appearance. The area is more or less surrounded by cultivation, chiefly rice fields. The following is a list of the principal species observed in the plantation (*indicates frequent

or abundant, ** very abundant) :—

**Anogeissus acuminata,*

*, *Bridelia retusa, Trema politorea,* **Azadirachta indica, Ailanthus excelsa, Hymenodictyon excelsum, Strychnos nux-vomica, Eugenia cumini, Alstonia scholaris, Ficus religiosa, Casearia tomentosa,* **Ipomoea pes-tigridis,* ***Tridax procumbens, Pogostemon plectranthoides,* **Oxalis corniculata, Ageratum conyzoides,* **Saccharum spontaneum* (at first abundant, disappearing as the canopy closes), *Oplimenus compositus* and a few other grasses not identified. It seems clear that *nim, Bombax, Bridelia* and *Anogeissus acuminata* will form an appreciable mixture in the crop as time goes on, which should prove useful as the *sissoo* was planted pure over most of the area after the failure of the *Casuarina. Khair* will be tried in future plantations.

The total cost of planting 206 acres and tending for 6 years amounts to Rs. 6,450 including compound interest at $3\frac{1}{2}$ per cent. on all expenditure including overhead charges. The revenue from cleanings and other miscellaneous items amounts to Rs. 140 for the same period. From now on, maintenance and supervision costs will be reduced and it seems certain that the undertaking will yield a very handsome return; especially if the present rates of growth are maintained.

A rough soil test carried out in the area of best average growth showed that the silt-*cum*-clay fraction was less than 4 per cent. of the whole, the balance being coarse and fine sand. In this locality the depth of sand overlying fertile (formerly arable) soil is about 4 feet, so it does not take the root of the *sissoo* long to penetrate the sandy layer.

———

REPRODUCTION OF THE ANDAMAN FORESTS

By B. S. Chengappa, P. F. S.

Mr. B. B. Osmaston in 1908 (Indian Forest Records, Volume I, Part III paragraph 1, page 241) says: "Saplings and young poles as well as trees below 6 feet in girth are very scarce indeed"......

This remarkable disparity in the age classes can only be explained by assuming that there has been a very recent change in the condition

THE ANDAMAN EVERGREEN JUNGLE—
PORLOB ISLAND

DIPTEROCARPUS ALATUS—PORLOB ISLAND
30FT. GIRTH, ABOUT 100FT. CLEAR BOLE

of the vegetation in the Andamans, the conditions under which the existing crop of mature and over-mature trees arose having given place to others unsuitable to the successful reproduction of padauk. Professor Troup in his book *The Silviculture of Indian Trees* says: "Frequently the change takes place by reason of conditions (moisture, shade, etc.) produced by the formation itself." What is true of padauk is also true of other deciduous and also of evergreen species, *viz.*, *gurjan*, *lambapatti* and *bakota*. Whatever may be the cause for this change we have now got to face the fact that the Andaman timber species now well-known in the market are only transient and a stage in the progressive succession towards climatic climax and may as Mr. Smythies says ("*Sal and its regeneration*," *Indian Forester* for April 1932, page 199, paragraph 10): "in the time space continuum fade away as a morning mist" unless Foresters step in and prevent this disaster. Therefore, extensive experiments, both natural and artificial, to secure their regeneration were tried from time to time and before the end of 1933, the problem of deciduous species was solved. (*Indian Forester* for January—March 1934.) Evergreen species, however, especially *gurjan*, remained refractory and Mr. Trevor, Inspector-General of Forests, in his "Note on a tour of inspection of the Andaman Islands, 1934," ordered that "the problem of regenerating *gurjan* is not yet solved and intensive research on this matter must be continued."

Silviculture Requirements of Gurjan.—A study of the silvicultural requirements of evergreen species, especially of *gurjan*, the reproduction of which was causing anxiety, revealed the following facts:

Gurjan is a collective name for all species of *Dipterocarpus* found in the Andamans, *viz.*, (1) *alatus*; (2) *grandiflorus*, (3) *turbinatus*; (4) *pilosus* and (5) *kherrii*.

Of these only the first is the most common and the second and third are the most frequently met with. Therefore, only these three species were studied.

1. *Dipterocarpus alatus.*—The giant of the Andaman forests grows at its optimum in the moist alluvium soil and moist valleys and depressions. It reaches a height of more than 140 feet with

nearly always a clear and cylindrical bole 70 to 80 feet and a girth of 16—25 feet.

It sheds its leaves in December and the new leaves appear almost immediately. It flowers every year in January but profusely once in two years. Paroquets destroy both flowers and green fruits to a considerable extent. The seeds ripen in April and May. They loose their vitality quickly and unless seedfall coincides with rainfall, germination rarely occurs. The seeds are winged and unless the ground floor is clean they rarely reach the soil.

In favourable years, when the monsoon sets in early, germination takes place in large numbers, even in thick jungles on undecomposed leaf mould and on branches and twigs. But they all die or decay if the monsoon is continuous and only those which have found the mineral soil survive.

The young crop has great power of persisting under heavy shade for at least one or two years and unless smothered by weeds and climbers (which is nearly always the case), slowly pushes its way through. This is, therefore, one of the few species whose younger age classes are sometimes met with. Half a dozen or more seedlings, one or two years old, are not uncommon under nearly all mother trees.

Gurjan seedlings do not seem to like heavy opening at least in their first year. Their growth is very slow and reaches about 2—4 feet in two seasons. Once they are well-established, *i.e.*, once they have passed through at least one dry season, a heavy opening of the tree cover is beneficial.

Artificial reproduction by sowing direct or putting in transplants was not a success. Planting seedlings from the jungle was also not a success.

Its power of reproduction by coppice is very poor ; plants up to 2 feet in girth coppice freely and above 3 feet rarely.

It has a smooth bark and a straight cylindrical bole. The climber-bound trees are, therefore, rare.

Deer eat them when they have no other suitable grazing.

2. *Dipterocarpus grandiflorus.*—The silvicultural requirements of this species are similar to that of No. 1 except that it is found only

on hills and hill slopes. It flowers in January and the seeds ripen much earlier than the others. They very often fall before the monsoon sets in with the result that they fail to germinate. The younger age classes of this species are therefore very rare.

3. *Dipterocarpus turbinatus*.—The silvicultural requirements of this species also are similar to No. 1. It is found on the hills and also on the flat alluvium. It flowers late, February—March, and the seeds are ripe in June. This species therefore reproduces itself better than the others.

Recent Efforts to Raise Gurjan.—Experiments to raise *gurjan* date back to the period it was put on the market but since 1933 these experiments have been carried out in Long, Guitar and Porlob Islands and Kyitaung in Middle Andaman Islands.

Long Island Experiment.—This island is covered completely with semi-deciduous jungle, fast heading towards climatic climax formation. *Gurjan* (only *alatus* and no other *Dipterocarpus* is found in this island) predominates and in places gives the appearance of an old *gurjan* plantation.

Thirty acres in this area were treated in January, 1933, by cutting all undergrowth, raising the canopy to 40 feet, and in April burning the slash. *Gurjan* flowered profusely but paroquets swarmed round like flies and destroyed both flowers and tender fruits and allowed only a few to reach maturity and to reach the soil. Germination was, therefore, poor.

Any advance growth already on the ground, in spite of precaution, died of excessive heat produced by the conflagration while burning the brushwood. A thick carpet of *koko*, padauk, etc., seedlings came up but before they reached six inches, deer destroyed them. Therefore, attempts to restock the area with *gurjan* seedlings from the adjoining jungle were made, but these also failed to establish themselves. Any that survived the heat and also all those that germinated after the treatment, were browsed heavily by deer after they had eaten up the more succulent plants. This experiment was, therefore, abandoned.

Guitar Island Experiment.—Vegetation in this island is very similar to that in Long Island. Except for the few top storey

trees, like *gurjan*, padauk and *koko*, everything else is completely evergreen.

In May 1933, six *gurjan* trees within about 12 acres were noticed to have a large number of mature seeds. The undergrowth was at once cut and the tree canopy raised to 40 feet. But due to past heavy fellings, the overhead shade could not be controlled and in many places big gaps were made. As it was then raining no burning was attempted but the mother trees were felled and removed in June immediately after seed-fall. Germination was complete and profuse in June and July and gave a dense crop of seedlings within a radius of 100 feet from the parent tree. A large number of these seedlings were pulled out and planted in places where such regeneration did not exist within these 12 acres. But these and also a large percentage of the germination, especially those on undecayed leaf litter, died in the first break of the monsoon. After the rains, further casualties occurred among the seedlings that were fully exposed and it was feared that the whole area as a *gurjan* experiment would be a failure. However, other species especially *white chuglam* (*Terminalia bialata*) and *lambapatti* (*Sideroxylon longipetiolatum*) had come up in large numbers and were growing well. *Toungpeing* (*Artocarpus chaplasha*) seedlings similarly planted were also doing well. So, even if *gurjan* had failed, this area would still have been completely stocked.

An examination in January and February, 1934, showed that a large number of *gurjan* seedlings were still flourishing. But what was most puzzling was that sickly and dying plants were found side by side with very healthy and robust plants, both under heavy shade and in the open. The sickly plants were easily pulled out and their root system showed that they were affected by some disease. The healthy plants could not be pulled so easily.

In 1934 and 1935 the young crop was kept weeded and the tree canopy gradually raised until it is nearly open now. The whole area is at present completely stocked with *gurjan*, forming about 35 per cent. of the crop. Around the stumps it is almost pure *gurjan*. The best height is 9 feet and the average height is 6 feet 3 inches and the best growth is in quite open patches.

GURJAN—THREE YEARS OLD—GUITAR ISLAND

LAMBAPATTI—THREE YEARS OLD—GUITAR ISLAND

These two experiments showed that—

(1) Paroquets should be kept out of the way from the flowering stage.

(2) Burning that is indispensable in deciduous jungle is definitely harmful for *gurjan* as it is extremely difficult to protect the seedlings of these fire-tender species.

(3) Initial cutting of 40 feet is too heavy an opening for the unestablished seedlings of this species.

(4) Deer browse heavily and destroy the plants when they have nothing else more succulent to eat.

Further experiments were accordingly tried in Porlob Island and also in Kyitaung Middle Andaman Island.

Experiment I, Porlob Hill, Porlob Island.—In Porlob Hill, a typical hill evergreen forest, an area of ten acres was treated in January 1934 by cutting all undergrowth and all shrubs up to a height of 10 feet from the ground. The *gurjan* in this area is mostly *turbinatus*. The seeding of this species in 1934 was poor, it was therefore left to itself. In 1935, however, the seeding was good and so also was germination. The area is now covered with a large number of *gurjan, lambapatti* and *red bombwe* (*Planchonia andamanica*) seedlings. Nothing further has been done here—not even weeding as it is an isolated patch and the main object was to see whether germination could be induced. Further development of the seedlings is being watched.

Experiment II, Lal Tikri Hill, Porlob Island.—In 1930 and 1931 when the adjoining areas were taken up for treatment to raise padauk, and other species, this hillock, 29 acres in extent, a typical hill evergreen forest, was carefully left alone as the silviculture of evergreen species was very little known then. The only *gurjan, Dipterocarpus grandiflorus* found in this area had mostly been removed in the past fellings. What was left behind was some *Ficus*-bound *gurjan, Myrstica* and other useless tree-growth. Few seedlings of *gurjan* in occasional patches were also struggling for existence.

Early in 1934 undergrowth was cut and the tree canopy raised to 20 feet. Wherever patches of *gurjan* seedlings were found, the

canopy was raised to 30 feet. In June some germination of *gurjan* was noticed. As this was not considered sufficient to completely stock the area, *white chuglam*, *white dhup* and *papita* were proposed to be planted in July. Before this was done, there sprang a pleasant surprise in the appearance of *lambapatti* seedlings in large numbers completely filling up the whole area. It was more so because of the complete absence of any *lambapatti* tree within a radius of at least two miles of this hillock. It was, however, soon discovered that the Andaman Imperial pigeons were the means of sowing these seeds. *Lambapatti* fruits get ripe in dry weather and these birds voraciously swallow them. In dry weather they usually roost in evergreen jungles and drop the seeds undigested.

The area was kept well weeded in 1934 and 1935 and the tree canopy gradually raised to 80 feet. Both *gurjan* and *lambapatti* are now growing very well—*lambapatti* is very much faster and is already 8—10 feet high.

Experiment I, Kyitaung—75 acres.—Kyitaung, a typical hill evergreen forest, was felled over for extraction early in 1933, after a careful selection of *gurjan* mother trees—*gurjan*, unlike *padauk* and other deciduous species, are usually sound and straight. Therefore, with the only guide of a girth limit of 9 feet and over for exploitation fellings, it invariably happens that very rarely any tree to sow seeds is left behind—*Dipterocarpus alatus* on the lower slopes, *grandiflorus* and *turbinatus* on the ridges and higher slopes and also *lambapatti* formed the predominating species.

Immediately after the fellings about the end of 1933, this area was taken up for treatment. As a fair amount of advance growth of *gurjan* in small patches was found scattered over the whole area, the undergrowth was cut and the tree canopy raised to 30 feet. The mother trees flowered profusely and the paroquets were again there in their thousands. But Bush Policemen who were stationed here for protection against Jarawas—a hostile tribe whose only contact with civilization is with his arrow usually shot through the chest of some unfortunate man—were detailed to expend their usual quota of ammunition on these birds instead of firing blank to scare away these

implacable wild tribes. This had the desired effect, seeding was profuse, rainfall was timely and germination was therefore abundant and the whole area except for small patches was one mass of *gurjan* seedlings in July. Besides these, *lambapatti, red bombwe* (*Planchonia andamanica*) and *toungpeing* (*Artocarpus chaplasha*) also came up and filled up the area completely. Sample patches were counted and as many as 15 to 25 thousand *gurjan* seedlings per acre besides others were found. (This is by no means the average for the whole area.)

The area was kept weeded in 1934 and 1935 and the canopy gradually raised to 60—80 feet according to the requirements of the young crop. It was indeed found that heavy opening was necessary once the seedlings had passed one dry season. Casualties were unknown. The young crop is now more than three feet in height and the whole area is a success beyond expectation.

The highly successful results of 1934 *gurjan* regeneration experiments led to their repetition in 1935 also.

Experiment in Kyitaung.—An area of 78 acres adjoining the 1934 area in Kyitaung was demarcated and was similarly treated. The initial felling was limited to 10—20 feet from the ground as there was no trace of any *gurjan* seedlings on the area. It was also unfortunately a poor *gurjan* seed year. Therefore the whole outlook was very gloomy. However, *lambapatti, red bombwe* and also *bakota* (*Endospermum malaccense*) came up in sufficient numbers. The area was, therefore, kept weeded and the tree canopy raised to 30—40 feet. Fortunately, 1936 has been a very good *gurjan* seed year and the rainfall also has been early. *Gurjan* germination has, therefore, been profuse in this area. So, what once looked like a *lambapatti* area will now be a *gurjan-lambapatti* area. It does not present any unsurmountable difficulties to obtain the development of *gurjan* seedlings once their germination is secured.

Mr. Trevor, Inspector-General of Forests, in his Inspection Note, February 1936, says: "In the Kyitaung and Guitar Islands regeneration areas visited by me, complete regeneration of *Dipterocarpus alatus* and *grandiflorus, lambapatti*, some *white dhup* and *papita* has been obtained by clearing undergrowth to 30 feet in 1933

and subsequent rains, weeding and lightening the canopy from below upwards. Seventy-five acres of *gurjan* have been thus regenerated in 1934 and 80 acres in 1935 and the staff have now demonstrated that they can regenerate an area of deciduous or evergreen forest with no particular difficulty."

Future of the Forests.—The treatment developed naturally resolves itself into conversion to uniform method. Therefore, the work is now organised accordingly. Fifty square miles, an area heavily worked in the recent past but very accessible and easily worked at any time of the year and also reasonably close to Port Blair, are now allotted to Periodic Block No. I, to be regenerated in 30 years. The *rotation* is fixed at 150 years. Periodic Blocks Nos. I to IV are combined and selection fellings on a girth basis of *gurjan* 9 feet and above, *padauk* 7 feet and above, *white chuglam* 8 feet and above, and the rest 6 feet and above, continue to be made in this area.

The minimum area to be regenerated in any one year is fixed at one square mile but it is hoped to regenerate at least 1,000 acres every year. It has been found that more than 100 to 150 acres in any one centre is not a good unit for management. Therefore, the area to be regenerated is distributed into seven centres, each managed by a Forester and the areas under each Forester raised or lowered according to funds and labour supply available. The camps are so arranged that at the end of ten years there will be a compact block of 3,000 acres or less according to the area available in each island completely regenerated.

"Follow up exploitation fellings closely by regeneration *fellings*" is the general rule as this reduces the cost of regeneration enormously. But this is not found possible owing to the arrears of regeneration to be made good and also due to the past irregular fellings. However, every year before the end of the hot season 100 to 150 acres in each centre are demarcated for the following years' work and all saleable timber in the area removed before the end of November, and *immediately after seeding or initial felling* is taken up. In every case of initial felling, undergrowth is first cut to facilitate marking

for the manipulation of the canopy. Also, these trees in their fall press the undergrowth to the floor and help a better burn.

Method of executing fellings.—The following rules are evolved for the execution of regeneration fellings as a rough guide to the marking officer. These are by no means complete or final :—

A.—Regeneration fellings in deciduous and semi-deciduous forests

Initial or seeding felling.

(1) Marking for extraction of any saleable timber in the area should be done in June or earlier and a list of timber available prepared.

(2) Twelve to 15, preferably unsound trees (at least five padauk) capable of producing sufficient fertile seeds and well distributed about 50—60 feet apart should be reserved for seed purposes.

(3) All climbers should be cut while marking, especially on seed trees.

(4) Every padauk below 4½ feet in girth, *papita* and *dhup* below 3½ feet, and others below 4 feet in girth, should be reserved to form part of the future crop.

(5) Any timber available in the area for sale should be extracted before the end of October of the year in which it is due for regeneration fellings. The exploitation fellings should not be carried out unless the area can be immediately regenerated.

(6) In November-December the undergrowth and tree growth up to a maximum of 60—80 feet from the ground should be cut down.

(7) Uniform overhead shade should be aimed at. If no tree growth is available to form shade over a patch or a gap small trees should be reserved to cover the ground.

First year seeding felling.

(1) Burning the brushwood should be done before the second week of March. No heaping before burning is necessary, but the idea is to clear the ground sufficiently to allow seeds to reach the soil.

(2) Seeds of padauk, *dhup*, *papita* and other species should be collected in sufficient quantities as they become available and these

should be sown broadcast in April or May wherever seed-bearers have not produced sufficient seeds. If, for any reason, burning is delayed till the end of March, *papita* seeds should be collected and sown broadcast to ensure a proper proportion of this species. *Papita* seeds usually get destroyed, however light the fire may be, and its seedfall occurs usually after the second week of March.

First year, secondary fellings and weedings.

In June or July the seedling crop appears and this should be kept weeded according to the requirements of the young crop. Two, sometimes three, or even four weedings may be necessary.

1st weeding.—June-July or August. This depends upon whether the rainfall is early or late.

2nd weeding.—November-December.

3rd weeding.—February-March.

In the first two weedings the weeds should be uprooted as far as possible. After the second weeding, usually in November-December the canopy should be raised to 80—100 feet or less according to the requirements of the crop by girdling the unwanted species.

Second year, secondary felling and weeding.

(1) Two weedings are usually needed during this year.

1st weeding.—June-July.

2nd weeding.—November-December.

3rd cleanings.—February-March. Climbers and miscellaneous species to be cut and also relieving congestion of plants where necessary.

(2) The canopy should be raised to 100—120 feet in November-December by girdling immediately after the 2nd weeding. In rich calcareous soil like that in Guitar Island complete removal of over-head shade may be necessary.

Third year, final felling.

(1) *1st cleaning.*—June-July. Climber cutting and cutting back miscellaneous species and relieving congestion.

2nd cleaning.—January-February. Climber cutting and cutting back miscellaneous species and relieving congestion.

(2) *Final felling.*—January-February or earlier. The overhead shade should be removed completely by girdling. If, in any part of the area, the average height of the crop is not more than six feet, the canopy should be left at 100 feet. The height of the spectacular species like *dhup* and *papita* should not be considered.

Cleaning and thinning.

Fourth year onwards—yet to be studied.

B.—REGENERATION FELLINGS IN EVERGREEN FORESTS.

Initial or seedling felling.

(1) Same as that for deciduous species.

(2) Same as that for deciduous forest except that 12—15 *gurjan*, *lambapatti* and other evergreen species should be reserved for seed purposes.

(3) Same as that for deciduous forest.

(4) *Gurjan* and other evergreen species below 4½ feet in girth should be preserved to form part of the future crop.

(5) Same as that for deciduous forest.

(6) In November-December, after cutting down the undergrowth, the area should be examined well. As a rule *gurjan*, *lambapatti*, etc., seedlings are always found under seed-bearers. If this is the case, raise the canopy to 20—30 feet by girdling. A deeper girdling is needed to kill quickly most of the evergreen species. If no seedlings are found, nothing more than clearing the undergrowth to 10—15 feet should be done. If necessary which would be very rare—this should be repeated every year before seedfall until germination is obtained.

First year seeding and secondary felling.

(1) Seed of *lambapatti* and other useful evergreen species should be collected in sufficient quantities as they become available and these should be notched in or dibbled in April and May wherever seed-bearers are not available or wherever they have failed to produce seeds. *Dipterocarpus turbinatus* seeds fall late and usually coincide with the rainfall. This is therefore the best species to grow. It also has no preference to any particular soil and is found both on the hills and on the low level alluvium. Its seeds also should be tried.

(2) Weeding should be carried out if necessary. Usually, there is need only for one weeding.

(3) In November-December, after a weeding or two and if the young crop is about a foot high, the tree cover should be raised to 30—40 feet by girdling the unwanted trees.

Second year, secondary fellings.

(1) Weed according to requirements of the crop.

(2) Raise the canopy to 40—60 feet or even more in June-July or immediately after a weeding. The canopy should be raised again in January-February to 60—80 feet or even 100 feet. Once the seedlings have passed one dry season, the canopy should be raised as quickly as possible.

Third year onwards.

Yet to be studied.

N.B.—No girdling at any stage should be done at a time when the monsoon winds blow hard. It is advisable that this work is done in calm months.

Conclusion.—It is now conclusive that natural regeneration of all Andaman timber species, both deciduous and evergreen, including the much-dreaded *gurjan*, can be induced and their development secured at a cost of Rs. 25—30 per acre by clearing undergrowth completely, lightening the tree canopy from bottom upwards gradually, burning the slash where necessary and weeding frequently (climber cutting and other subsequent tending costs after three years not included in this figure). Equally good results at a much lower cost have been obtained by following exploitation fellings closely and varying the treatment *slightly*. But *still*, no *finality* has been reached and nothing is yet standardised. Experiments are still in progress to improve the technique and to reduce costs especially that of *gurjan* and its associates.

Mr. Trevor, Inspector-General of Forests, in his Note of Inspection, February 1936, says: "We have now reached the position of being able to regenerate any species at will but we know nothing about the subsequent tending of such mixed crops or how best to arrange the mixture, and these matters should receive the constant attention of

the silvicultural staff. Further, we have to decide what species we want and their correct proportions in our new crop. In dealing with this question, I would advocate an extension on the quantity of *lambapatti* which is the best splintwood in India and which should command a premium over *dhup* and *papita*."

Thinning was tried in crops 3 to 4 years old. In thinning the aim was to mix in groups and also to bring the crop into a line with plantations so that subsequent thinning becomes easy. Therefore lines 8 feet apart were laid and along these lines plants 2—3 feet were left and everything else was cut. This certainly gave the appearance of a plantation with a planting distance of 8 feet × 2-3 feet. It was, however, soon discovered that it was much too early as the increased light on the soil stimulated prolific growth of climbers. Also the attempt to increase the proportion of padauk in 1931 area—14 acres—in Lal Tikri resulted in its being converted into a pure padauk forest. So, the important problem of when and how to thin and tend and also how to arrange mixtures is still under investigation.

However, the fundamental principles of silviculture, of growing each species in the locality most suited to it, will be followed. Padauk is the most valuable species and will obviously continue to be so in future. Therefore, every attempt will be made to increase its proportion to about 33% of the new crop in localities most suited to it. The mixture will be in groups as far as possible and it is hoped that the resultant crop will be one in which all species are represented in little groups of their own.

TREE LOPPING ON A PERMANENT BASIS

By R. Maclagan Gorrie, D. Sc.

All the Western Himalayan oaks provide a valuable fodder, and it has been the custom in the past to lop them on a definite rotation of 2 or 3 years. Unfortunately the economic pressure of increasing population, and the gradual exhaustion of other fodder sources through misuse and over-grazing, have all combined to intensify the demand for all types of fodder. Also the reservation

of tracts as Government forest with ill-defined but generally much too liberal rights and privileges has led to an increasing disregard for the continued productivity of such areas. This is particularly noticeable in the case of the oaks.

Where these trees occur inside a Government forest but within easy distance of any village, they are heavily lopped each year, and soon tend to disappear, being replaced either by a heavy weed-growth or by some other less exacting tree species such as *Pinus excelsa*. On the other hand, single oaks or groups of trees in village lands are carefully apportioned amongst the owners or tenants, who lop them only after they have reached a reasonable size, and on a regular rotation of 2 or 3 years. Plate 4 shows some of these trees in various stages of such a rotation, and indicate very clearly the striking difference in health and appearance between them and the more frequently reproduced photographs of stands destroyed by annual lopping. (*c.f.* plate 34 in August 1936 issue). Trees lopped on a rotation live to a reasonable age and yield a very large amount of fodder.

All six of the common oaks of the Punjab and the United Provinces suffer equally in this way :—*Quercus glauca* in the lower outer hills, *Quercus incana, dilatata* and *lanuginosa* in the middle elevations, *Quercus semecarpifolia* in the higher elevations, and *Quercus ilex* in the inner valleys, are all equally vulnerable whenever they occur near habitations. Possibly the outstanding example of wanton destruction of this valuable fodder resource is seen in the Murree Hills, where pressure of increasing population, the growth of the dairying trade for the Rawalpindi and Murree cantonments, and the rapid exhaustion of other fodder sources, have combined to throw a heavy demand on the oak ; the *Q. dilatata* in Burbhan Reserve near Murree was until a few years ago a magnificent piece of woodland, well worthy of preservation as a national monument, but it is now alas in the last stages of decay, with blue pine usurping the place of the oak. Almost everywhere one goes in the hills it is the same story, the oaks everywhere in accessible Government forests have been so mutilated by continuous lopping that they are rapidly

OAK TREES AT MANALI LOPPED ON A 2-YEAR ROTATION; THESE HAVE BEEN LOPPED OVER A YEAR AGO AND NOW BEAR TWO SEASONS' GROWTH OF FOLIAGE, WHICH WILL BE LOPPED AS FODDER IN THE COMING WINTER

OAK TREE NEAR MANALI, KULU, LOPPED EARLY THIS YEAR ON A 2-YEAR ROTATION, AND NOW THROWING OUT A FRESH FLUSH OF LEAVES

Photos: R. M. Gorrie.

dying out, whereas those growing on private holdings, or on common land where the ownership goes by individual trees, are properly treated and maintained in a healthy and productive condition. Where these photographs were taken, it is a criminal offence punishable by the village committee if any owner sells his oaks or allows them to die through over-lopping. Trees treated on a definite rotation like those now illustrated are capable of living to a good old age and remaining productive almost indefinitely, whereas heavy and unregulated lopping will very soon kill all our oak.

In view of the fresh interest now being taken by the authorities in the milk supply for school children, it would seem a thousand pities to allow this most valuable winter supply of cattle fodder to pass away through deliberate misuse. Surely it is not beyond the persuasive powers of our forest staff to show the villagers that they are pursuing a terribly short-sighted policy in this respect. I would suggest that valuable groves of oaks now threatened in this way should be apportioned out as single trees to individual right-holders on condition that they make themselves responsible for their preservation.

PRECISION OF THE STANDARD INDIAN SAMPLE PLOT METHOD

By M. A. Kakazai, Statistical Assistant Silviculturist, F.R.I.

In an article in the *Indian Forester* of October 1934 the Central Silviculturist dealt with the value and purpose of crop increment sample plots. He also discussed the precision of the estimates of crop statistics calculated by the Standard Indian Sample Plot Method as laid down in Silviculture Research Manual Vol. II (The Statistical Code) by comparing them with actual measurements of two plots in Buxa clear-felled immediately after taking the standard measurements.

As several more sample plots have been clear-felled since it was considered desirable to study figures from all such plots, the results of this study are summarized in a tabular form below :—

COMPARISON OF CROP STATISTICS OBTAINED BY—

(*I*) *The Form Factor-Height Curve Method using about 6 selected sample trees only.*

(*II*) *The Direct Measurements after Clear-Felling.*

Species	Division	S. P. No.	Date of clear-felling	Age.	No. of sample trees	BASAL AREA PER ACRE			AVERAGE DIAMETER			AVERAGE HEIGHT			STEM TIMBER VOLUME PER ACRE			STEM SMALL-WOOD VOLUME PER ACRE			TOTAL VOLUME (INCLUDING BRANCH) PER ACRE		
						I	II	Per cent. difference from II	I	II	Per cent. difference from II	I	II	Per cent. difference from II	I	II	Per cent. difference from II	I	II	Per cent. difference from II	I	II	Per cent. difference from II
						(A) In Sample Plots in Natural Crops																	
Dalbergia sissoo	Lansdowne ..	1	1935 Apl.	45	6	51·5	51·3	+0·4	12·7	12·6	+0·8	75	73	+2·7	865	885	−2·3	315	301	+4·7	1500	1455	+3·1
Morus alba ..	Lahore ..	27	1934 Nov.	14	6	66·9	66·6	+0·5	8·1	8·0	+1·3	53	52	+1·9	586	515	+13·8	913	878	+4·0	1664	1565	+6·3
Shorea robusta	Buxa ..	1	1927 Mar.	74	6	110·6	109·8	+0·7	12·1	12·1	0	81	80	+1·3	2119	2097	+1·0	1133	967	+17·2	3746	3586	+4·5
Do.	Buxa ..	2	1927 Mar.	93	6	84·0	82·8	+1·4	16·6	16·5	+0·6	88	86	+2·3	2392	2280	+4·9	211	229	−7·9	2946	3013	−2·2
Do.	Ramnagar ..	36	1934 Nov.	102	7	113·4	112·5	+0·8	19·5	19·4	+0·5	106	106	0	3650	3580	+2·0	233	225	+3·6	*3916	*3980	−1·6
Do.	Bahraich ..	12	1935 Feb.	103	6	138·0	137·2	+0·6	21·6	21·6	0	103	103	0	4079	4038	+1·0	184	193	−4·7	*4617	*4457	+3·6
						(B) In Sample Plots in Plantations																	
Dalbergia sissoo	Montgomery..	5	1934 Oct.	15	8	61·6	60·7	+1·5	6·4	6·4	0	46	45	+2·2	129	136	−5·0	1114	1089	+2·3	1345	1313	+2·4
Do.	Montgomery..	6	1934 Oct.	15	7	62·5	61·9	+1·0	6·1	6·1	0	44	44	0	146	136	+7·4	1121	1044	+7·4	1348	1248	+8·0
Do.	Montgomery..	8	1934 Oct.	15	12	55·1	54·6	+0·9	7·0	7·0	0	50	47	+6·4	200	177	+13·0	935	883	+5·9	1195	1146	+4·3

**Branch smallwood volume is not included.*

The figures of percentage differences in the statistics calculated by the two methods for sample plots 1 and 2 of Buxa division given in this table do not agree with the figures in the paper referred to as they have been based on the actual statistics instead of the calculated statistics.

The statistics of sample plots in natural crops have been tabulated separately from those of sample plots in plantations. The results show that estimates of crop statistics by the Standard Indian Sample Plot Method of strictly even-aged plots in plantations involve errors of the same magnitude as occur in the estimates of crop statistics of plots in natural forests with an appreciable range of age.

Differences exceeding 5 % were examined with a view to finding out any special reasons for them and the following notes deal with the sample plots in which they occurred.

Lahore S. P. 27.—The actual volumes of stem timber and stem smallwood of 18 stems of 7 inches to 8 inches d. b. h. had to be obtained by drawing volume curves from data of other trees inside the plot and this curve had to be extrapolated downwards thus reducing the value of the figures corresponding to actuals. This may have reduced the figure of actual timber which affected the total volume also.

Buxa S. Ps. 1 *and* 2.—The causes for the big differences in stem smallwood are difficult to ascribe; however, the great divergency in volumes of stem smallwood in trees of same size renders it impossible to select truly representative sample trees and the stem smallwood is unimportant in these mature crops.

Montgomery S. Ps. 5, 6 *and* 8.—The measurements of timber in stems of 7 to 8 inches d. b. h. were accidentally omitted and similarly the timber in a few trees above 8 inches d. b. h. was also not taken. The actual volumes of stem timber and stem smallwood of 25, 15 and 46 stems in plots 5, 6 and 8 respectively were therefore obtained in the same way as described for sample plot 27 Lahore and this may have caused the large difference.

Further, the stem timber form factor curves of sample plots 5 and 6 had to be drawn on two points only which could not be expected to give reliable curves.

Lastly an examination of the record of heights of all the trees of sample plot 8 showed that the heights of sample trees were superior to the heights of other trees of same size in the plot thus causing a higher estimate of average height which naturally affected the volume in the same way.

Summary.

Out of 9 sample plots studied, all the statistics of 3 sample plots (all in U. P. in natural forests) agreed within 5 per cent.

The value of actual statistics of 4 sample plots (all in the Punjab—3 in plantations and 1 in natural forests) was reduced by the omission of the measurement of timber in many stems, so that the comparison does not constitute a real test of the precision of the Standard Indian Sample Plot Method.

In the two Bengal plots only the unimportant stem smallwood showed a significant difference.

VILLAGE UPLIFT AND ITS CONNECTION WITH FORESTRY

By K. D. Joshi, Deputy Conservator of Forests, Pauri, Garhwal.

There is already an extensive propaganda and real work is being undertaken on the rural uplift in every Province in India. Many of the Forest Officers may have been silently assisting in the programme but what I would wish to see is that in any scheme of village uplift, the co-operation of Forest Officers is actively sought. To ignore their existence or in any way to belittle their importance would be fatal to any such scheme being undertaken. It is quite unnecessary to stress the point at this stage as to what importance the forests have in any scheme concerning the well-being of the villagers. Wherever forests exist in the neighbourhood of villages or where new areas are being afforested both as regards the tree as well as fodder growth, the intimate and the day-to-day contact with the villagers is evident. To take only one example and that of the improvement in the breed and the upkeep of cattle the forests necessarily play a very large part. Where grazing grounds already exist in the vicinity

of villages, the question of improving the quality and quantity of fodder species should receive the attention of the Forest Officers. It would be possible in places where no such grounds exist, to start new ones now and the way in which this should be done should again be left to the advice of the neighbouring Forest Officer. It will be just like the cart being placed before the horse if in any scheme of cattle "uplift," if I may use the word, the question of the fodder supply is neglected.

There are many other village uplift schemes which bear an intimate connection with the forests. There is the much vexed question of diverting the cow dung to its legitimate use as manure for the fields. In several villages cow dung is wrongly being burnt as fuel for want of any other substitute for the latter. In all such cases the vital problem of setting apart of a small area for some sort of tree growth is indicated. Here again the active co-operation of a Forest Officer is absolutely essential. I could thus name several items that would have a very little chance of success if a Forest Officer's assistance is not requisitioned at the very start.

I know that there are scores of such items that would come out of oblivion, once the district authorities seek the assistance of the neighbouring Forest Officer, and, where there is none, the Silvicultural or the Research branch in the province would gladly afford all facilities in placing all the information at the hands of the district authorities.

To the Forest Officers I would appeal that even in cases where their help is not asked, even unsolicited advice from them would go a long way to solving the various problems connected with the rural uplift in India. In these days of noisy propaganda their silent work may not catch the eye of the public and to deny the valuable assistance that a forest officer can render to India at this time would be almost criminal. Moreover, to popularise the forests, this time is a God-send and if we can prove to the public what we can do by showing them the ways and means to achieving success, much of the knowledge of forestry should filter down to the public ; for after all the forests in India are entirely meant and kept for the good of the country and any increase in the forest growth of the country would help in furthering the well-being of the people.

It would be a happy day when the forest officers come out of their seclusion and show to the people what they have achieved and what more they can do in any scheme of village uplift directly or indirectly. If my short note could catch the eyes of all forest officers in India I would feel doubly happy. If any forest officer at this time, busy in solving any such problem, would come out with what he has done by publishing his work in the *Indian Forester*, the country would be grateful to him.

Lastly my appeal is to the District Officers in India to utilise the services of Forest Officers in order to bring success to the various schemes engaging their attention.

CONFERENCE OF FOREST OFFICERS, BENGAL.

Forest Officers of Bengal have recently concluded a Conference at Darjeeling with Mr. W. Meiklejohn, Conservator of Forests, Bengal, in the Chair.

The Honourable Member in charge of Forests, Khwaja Sir Nazim-ud-din, K.C.I.E., opened the Conference on the 12th October.

The Conservator of Forests, in his introductory address, drew attention to the fact that this would be the last Conference under the present form of Government, and that the Department would not much longer have Sir Nazim-ud-din as its Member. He expressed the feelings of all Forest Officers when he stated that the Honourable Member had had during his term of office the interests of the Forest Department at heart and had lent all his weight to schemes to improve it and assist its progress.

The Honourable Member then gave an address, calling attention to the steadily increasing revenue of the Forest Department during the past two years. This, he said, was a sign of improved trade conditions, but at the same time he was convinced that the increase was also due to the efficient and able management of the Conservator of Forests and other Forest Officers. He congratulated Divisional Forest Officers on the way they had managed the forests under them and had enhanced the revenue in spite of drastic retrenchment.

He also drew attention to the fact that the Dacca-Mymensingh Division had for the first time shown a profit this year and he hoped for a gradual rise in the future. Mention of the establishment of the Forest Utilisation Officer on a permanent basis at Calcutta was also made.

The Honourable Member then gave valuable advice on methods of sales and disposal of forest produce, in particular, the inadvisability of permitting monopolies.

He also referred to outstanding grievances of Subordinates and regretted that owing to the financial stringency Government had not been able to bring into effect the proposed schemes.

It is interesting to note that Government is to examine the condition of Forests in West Bengal, and the Honourable Member hopes that a scheme will be put up by the Conservator of Forests with the consent of the landholders, on the lines of the Dacca-Mymensingh Forests.

He was of opinion that disforestation of these forests was, to a large extent, responsible for the deterioration of the soil in Bankura and Birbhum, and that re-afforestation would materially benefit the economic condition of the District.

In conclusion, the Honourable Member referred to the prospects of the Department under the new Constitution and stated that he was convinced that it would see little changes as far as its future status was concerned, as it and its officers were fully safeguarded.

The Honourable Member then declared the Conference open, remaining to listen to the technical discussions on the agenda for that day.

The Conference met daily from Monday, 12th October to Saturday, 17th October.

Papers on various technical subjects were submitted and discussed. In addition to these, matters concerned with policy and internal administration were considered and resolutions framed.

The Conference was attended by all Indian Forest Service Officers in the Province.

TOUR IN SOME PRIVATE FORESTS OF GERMANY

BY R. N. DE, I.F.S., DY. CONSERVATOR OF FORESTS, KACHUGAON DIVISION, ASSAM.

While visiting the Soil Research Institutes on the Continent and elsewhere during the last leave, an excellent opportunity presented itself to the writer for touring in the private forests of Germany, which is one of the foremost countries in the world where scientific forestry has been practised for nearly two centuries. For instance, record is available from the year 1777 of the Colditzer Revier Forest in Tharandt and systematic management under a Working Plan was started by Cotta in 1821 and the oldest sample plot in that forest was laid out in 1850.

In America, in the past, the method of working the private forests has been to take lease of an area, put up saw-mills, skidders, temporary railway lines and other mechanical means and go through the forest in 20 or 30 years' time and then, when there is nothing to cut, shift to another area. This method, to say the least, being most destructive to forests, the more thoughtful people have begun to realise that such a practice cannot go on for ever. Forest property has not been managed in America in the way the Germans have done for decades, and to those Americans who have been accustomed to these conditions, sustained yield hardly conveyed any meaning. It was with a view to demonstrate the possibility of managing private forests on the basis of sustained yield without destroying them for ever, that a party of Americans consisting of saw mill and paper pulp mill proprietors, directors and others were sent out, at the instance of the President, for a trip to Germany under the Karl Schurz Memorial Foundation. Dr. Heske, Professor of Forestry of the School of Forestry at Tharandt in Saxony, organised the tour and luckily the writer and his friend Mr. K. D. Joshi, I.F.S., of U.P., accompanied the party with Dr. Heske. The following account of tour excursions may prove to be of some interest. The party assembled in Hotel Europäsherhof in Berlin, where motor coaches were engaged to take them to the estate of Baron von Kreudel at

Hohen-Lübbichow, at a distance of about 60 miles from Berlin. They reached there by 12 noon and were very cordially received by the Baron and ushered into a big hall where lunch was served. A short note of the forest was made at lunch after which members of the party were conveyed to different parts of the forest in the farm wagons drawn by big horses, the roads through the forests not being in good condition for the motor buses in August after rain.

Hohen-Lübbichow is a middle-sized estate of about 7,000 acres in Saxony. Forest covers about 4,500 acres, mainly of loose sandy soil, and the balance of 2,500 acres consisting of the best soil is given for cultivation to 60 families. Thirty families of forest workers have been settled in the forest area and have got also land for cultivation. There is a nice compromise here between Forestry and Agriculture. In the cold weather when there is snow on the ground, there is no cultivation and this is the time for forest work. The workers are, therefore, happy and contented and have lived for generations on the estate of the Baron.

The forest has been a source of fuel as far back as 1150 A. D. when the Slavs invaded Saxony. It came down to the Baron's family from his maternal side from 1820 A. D. In the olden times, the forests were burdened with rights, *e.g.*, the right of lopping, grazing, etc. These were very harmful to the forests, as lopping produced wounds in scotspine which then became infected by fungi, and grazing over the whole forest spread the manure over too large an area to be of any appreciable benefit.

With the help of the Prussian Kings, a law was enacted by which the right of grazing was bought up by the big landholders and the cattle which hitherto roamed over the whole forest, now being stall-fed, produced manure which could be very profitably collected and utilised in the fields. The right of lopping branches was exercised to some extent till 25 years ago when it was finally extinguished.

The owner who has been a "forstmeister" himself under the Government, takes very keen interest in his forest. He has record of his forest property from the year 1824 A.D. Up to the 18th century,

the forest produced some of the best oak (*Quercus sesseliflora*) but lopping and grazing left it in a very poor condition. Good management, after the extinction of the rights, started in the beginning of the 19th century and oak and scotspine were planted after clear-felling. The forest has vastly improved but the Baron is of opinion that pure stands degenerate the soil. He has, therefore, abandoned clear-felling and is gradually introducing a mixture of oak and scotspine by cutting down the inferior stems of pines here and there. In some localities, hornbeam has also been transplanted.

After visiting different parts of the forest, the party was served with tea in the afternoon. More forests were seen before nightfall and then after a dinner during which the Baron was profusely thanked by members of the party for his hospitality and for showing them round, a move was made upstairs to visit the trophies of different animals shot on the estate. A very large collection of skulls, horns and skins was kept in an excellent state of preservation.

There is no unemployment on the Baron's estate in which 90 families in all live and work. The Baron who is like a patriarch looks to their wants, and supplies them with work throughout the year. In summer they are busy with their own cultivation, in winter there is plenty of work in the forest. A very enjoyable and profitable day was spent in Hohen-Lübbichow and all returned deeply impressed with the management of a private forest for over a century.

The next excursion which lasted for 4 days was made in the Krummhuebel forests in Silesia. Seats were already reserved in the train and after a run of about 4 hours from Berlin, the party detrained and got into buses and stayed for the night at the Berg Hotel, in Teichmannbaude at an elevation of 800 ft. These forests belong to Count Schaffgotsch. His family have been the proprietors and rulers of the estate for the last 1,800 years. The total area of the estate is 62,000 acres of which forest consists of 57,000 acres. This vast property is bounded on the west and south by Czechoslovakia. The highest peak of mid-Germany, Schneekoppe, 5,400 ft. high, is situated in these forests in the Riesen Gebirge (giant mountains). Here again all good valley lands are kept for agriculture and lands

on hill slopes and tops have been kept for forest growth. There are five ranges of about 12,000 acres each, in charge of a "forstmeister" who is a university man and over him there is the "Oberforstmeister" and his assistant. Nine to eleven forest guards are attached to each range. These men are trained in the lower grade forest schools.

The forest consists chiefly of spruce (*Picea excelsa*) which forms 95 per cent. of the crop, scotspine covers 4 per cent., and beech, sycamore, etc. (*Acer* spp.) make up the balance of 1 per cent. Rainfall of the year is 40 to 55 inches and the rocks are chiefly granite, gneiss and mica-schists.

Spruce is a shallow-rooted species whereas beech and maple have deep roots and their admixture is an insurance against wind damage which is very serious in these forests and all prescriptions of fellings have been made on this assumption.

Elevation controls the growth of the species and management varies accordingly. The best forest is found at an elevation of 2,800 feet and is worked with a rotation of 100 years. Between this and 3,600 feet, the growth is slow and the rotation is 140 years. From 3,600 feet to 4,100 feet the forest is managed under Selection System, chiefly for the purpose of protecting the forests of the lower slopes against adverse climatic factors, *e.g.*, flood, landslip, etc. Above 4,100 ft. the growth is stunted and only scrub forest is met with. Such areas are given to grazing only.

As the elevation is fairly high, there is a great accumulation of humus generally and germination is exceedingly poor. Artificial regeneration is, therefore, chiefly resorted to. Strips 150 ft. wide are clear-felled against the wind direction and planted up with 3-year-old transplants. Spacing varies from 5·5 × 5·5 feet to 6·5 × 6·5 feet according to elevation, smaller spacing being resorted to in higher altitudes.

As mentioned before, the chief danger to which the crop is liable is wind. Snow in high elevations, not being very wet, is not heavy enough to constitute a danger. Larch was introduced in the spruce area in 1780 A. D. from the Austrian Silesia and now forms a good

mixture. Similarly deep-rooted species, *e.g.*, beech and maple, have also been introduced to minimise the damage by wind which usually comes from the south over the ridge and sweeps down the slope at a speed of about 70 to 80 miles per hour. An idea of the damage may be formed from the fact that in the years 1906, 1907 and 1925, about 15, 12½ and 20 million broad feet of timber was spoiled by the wind. Apart from felling against the direction of the wind, in the worst localities, *e.g.*, in Gross-Iser, the tops of trees along the windward edge to a depth of 20 feet are cut down so as to reduce the anchorage of the trees. One of the local forest officers has patented a method of lopping the tops of such trees and this is claimed to have saved the forest considerably since 1923.

Annual outturn of the forest is 25 million broad feet of which 75 per cent. is timber, 10 per cent. wood pulp and 15 per cent. fuel. The forest being far away from any railway line, thinnings cannot be sold well, and consequently spacing is rather wide. Average annual profit made on the forest property is 6 marks per acre (about Rs. 6). The forest is provided with a large network of roads; most of them are *pucca* and the property is exceedingly well managed.

Members of the party were much interested in everything they saw and after thanking Dr. Heske who took immense trouble to show them round, they dispersed for other trips.

The above account is given with the hope that it might catch the eye of some large forest property owners of this country who will find that it is possible to practise scientific forestry and yet derive a steady income, apart from keeping a rural population employed and contented.

REVIEWS

PROGRESS REPORT ON FOREST ADMINISTRATION IN THE UNITED PROVINCES FOR 1935-36

During the year under review, the weather conditions were far from favourable from the point of view of Forestry. Firstly, the rainfall was very scanty in the early part of the season causing considerable damage by fire in some areas. In fact the extent of damage done this year was more than three times as much as that of the last year. To cope with fire a new method was introduced in *Saharanpur* and *Banda* Divisions by installing a telephone system which, it is hoped, will ensure better control in years to come. Secondly, the damage due to frost was felt all over the province, especially in *Gorakhpur Division*, where saplings and seedlings suffered to a great extent.

The surplus revenue for the year was Rs. 21·36 lakhs, *i.e.*, Rs. 91,000 less than in the previous year. The fall in surplus is partly due to the fall in revenue and partly due to extra expenditure which included a substantial amount spent in replacing uninhabitable subordinates' quarters, especially in unhealthy localities. On the whole this year's financial result may be considered satisfactory; except for the last year's figure this year's is the highest so far obtained since the depression started.

Tauṅgya plantations received considerable attention from the department. The total new areas under plantation during the year were 2,434 acres. According to the Chief Conservator of Forests, the most striking achievement in *taungya* has been made in Saharanpur Division where the department is " making large scale and valuable plantations almost free of cost to the Government out of practically valueless forests."

No new afforestation work was taken up during the year but the work in hand has been done satisfactorily. A good sal seed year was recorded throughout the province.

The main objective in research continues to be the natural regeneration of sal. The Chief Conservator reports that recent experiments are progressing favourably and instances are given where completely successful regeneration from seed has been obtained.

The Afforestation Division continued its work on canal areas, planting 725 acres. Of more than departmental and local interest are the experiments to be started in the canal areas with the reclamation of *usar* by treating it with molasses, and the continued experiment with the plantation of *bhur* areas, of which there are extensive out-crops in many districts. The Chief Conservator notes that it is not actually difficult to grow shisham, khair and babul on *bhur*, but that frost, grazing and other secondary complications make progress difficult.

Supply of sleepers was on the whole satisfactory showing an increase of 56,000 sleepers over the last year. In addition to the usual purchasers, the Bikaner Railways bought some sleepers from the department.

The surplus from the resin industry is slightly lower than that of last year. This is partly due to poor demand and partly due to agreement entered into by the department for a smaller profit. Fire in the resin tapping areas was apparently responsible for the reduction in the yield of resin per 100 channels. A reduced rate of transport by lorries brought the cost of collection below last year's figure.

In spite of the fall in the price of lac from Rs. 17 to Rs. 12 per maund, the total revenue obtained by Jhansi Division was about Rs. 2,000.

Working plans for West Almora, Gorakhpur, Bahraich, Kalagarh and Tarai and Bhabar forests have been sanctioned and printed, and those of Jhansi, Haldwani and Landour Cantonment forests are almost ready for publication.

An excellent pamphlet entitled " Our Forests " has been compiled by Mr. Ford Robertson which in words easily intelligible to the layman describes how the U. P. forests have been acquired, how they can be preserved and how at the same time they can be destroyed on a short-sighted view of public needs.

It may be mentioned that the report is the first issued this year by any province and the Government Resolution on it was also issued with the same promptness. Will other provinces please note.

CURRENT SCIENCE

Current Science, which was founded in 1931, completed its fifth year in July last. The journal is published on the same lines and fulfils the same mission of giving publicity to various scientific researches carried out in India, as the corresponding popular science journal—*Nature*, published in England by Sir Richard Gregory. The journal has always an interesting opening article or editorial, the subject of which is selected from the leading scientific events of the day, and then follows an article or two or an address by some of the eminent scientists of India or outside. Letters to the Editor and reviews of scientific publications are the next important items. The journal ends with science news, notices of the various learned societies and universities of the country and educational intelligence.

The need of such a publication was felt for a long time by the scientific workers of India, who are working in the various Universities and Institutions, both on academic and technical lines, and whose number has increased considerably in the last decade. The inauguration of such a journal is now regarded as a definite step in the advancement for the cause of science in India. We wish our contemporary all success, and as the pioneer of this line in India, a permanent place amongst other important journals of the same order and importance in Europe and America.

K. D. B.

THE BENGAL FOREST MAGAZINE

(AN APPRECIATION)

Forest Officers in every province will certainly welcome the birth of a new periodical under the above title early this year, and we all extend our cordial greetings to this new baby.

It is no mean achievement on the part of the subordinates of the Forest Department of a province to be able to publish a quarterly journal. Although apparently it is supposed to be the official organ

of the "Bengal Forest Subordinate Service Association," it is really much more than that, and has already showed its mark as of intrinsic value in the domain of forest literature dealing with some major problems of the day. As such, it has been receiving the patronage of the superior staff (including the head of the province), whose best wishes and literary contributions find due places in the magazine.

Complaints have been made not infrequently, and perhaps not without reason, that the forest officers of Bengal do not want their successful results to get the light of the day and thereby help their confrères elsewhere to avail themselves of the former's practical knowledge and experience by publishing matters of common interest. In his tour jottings from South Bengal, Mr. Champion, the Central Silviculturist, wrote in 1934 (*Indian Forester*, July 1934):—"It will appear that the local officers are a bit shy of showing their work to visitors—it must be shyness, as they are too polite to be personal and the work is well worth seeing."

Bengal certainly does not prefer to be in the limelight as it might be the proud privilege of some others to be always so. If the paucity of published literature is an indication of the amount of real work done anywhere, Bengal will perhaps plead guilty to the charge of insignificant work, although she will not accept the premise as logical, as no one will agree to the converse being true either. Complaints have at times been made about lengthy and verbose annual research reports from some places, where the reader after going through the moraine of the accounts of "randomised replications of experiments" is left bewildering without any positive conclusion of ascertained facts. It is hoped that Bengal will not treat the readers with such unwanted material.

Notwithstanding, the fact remains that Bengal has been shy of publicity. But the interest evoked by Stebbing's three volumes of *Forests of India* has continued to grow, with the result that a recent publication has already come out, edited by Mr. E. O. Shebbeare (who was, for more than a decade, the Conservator of Forests in Bengal) and under the patronage of the Hon'ble Member in charge of the Bengal Forest Department.

What Bengal has attained during the last two decades in the domain of practical forestry may not have yet gained a wide publicity. The technique of artificial regeneration, so well established in the province, has all been learnt in the field. But there exists the natural scepticism about its theoretical aspect which might provoke academic discussions from *Pundits* that be. The great keenness shown by the subordinate forest service in fully co-operating with the superior controlling staff has been commendable; and it will certainly be interesting to read the accounts of different forest operations as described by officers who are actually entrusted with the practical details of them.

There have already been four punctual issues of the periodical in January, April, July and October, and it is hoped that subsequent issues will also come out with the same regularity and the editorial board will gradually improve its general standard so as to bring it on a par with some of the less important, but by no means less interesting, American forest periodicals like *Forests and Outdoors* which deal with different aspects of forest life and are not highly technical. So far there have been quite a number of instructive articles of silvicultural interest, and I may be permitted to suggest that the Department might encourage a series of articles on the utilisation of major and minor forest products and information regarding their sources of supply, with a view to serve the purpose of publicity and propaganda which are so essential in these days of economic competition.

The effort on the part of the subordinates of a province in bringing out a magazine is unique and deserving of the best encouragement from all classes of officers as well as from the public.

J. N. SEN GUPTA.

AN INDEX OF THE MINOR FOREST PRODUCTS OF THE BRITISH EMPIRE

IMPERIAL ECONOMIC COMMITTEE

Press Communique

(*Release Date Friday* 14*th August* 1936.)

Hardly a day passes without news concerning the production of regulation of supply of some staple commodity such as wheat, milk

or tin. Meanwhile trade still goes on in a host of lesser products of which little is heard and about which information is difficult to procure. The forests of the world have always been a great source of such products. Some of them, such as rubber, cinchona and the oil-palm have advanced from the stage of minor products of the forest to regularly cultivated crops. Similar changes may occur again, but all the time, trade in a number of comparatively little known products (some of it international, some of it only local) still goes on.

An Index to these minor products of the forests of the British Empire, compiled by the Imperial Economic Committee in consultation with the forest departments of the Empire and with the assistance of Kew and the Imperial Institute, has just been published.* The Index is the first of its kind. In it the various minor forest products (defined as any product of the natural forest other than timber and its derivatives) are classified under drugs and spices, dyes, essential oils, fibres, gums, and resins, oils and oilseeds, tanning materials, and miscellaneous products. These sections, each prefaced by a short introduction, give for each commodity the trade name, the botanical species and the country of origin, and indicate whether an export trade has already been established, and, where it has not, whether in the opinion of local officers, the economic possibilities are favourable or slight. References are also given to a select bibliography from which more detailed information can be obtained.

Some 580 products and over 500 species have been listed from 36 countries in the Empire, and over 400 bibliographical references are given. Such a compilation should be useful to merchants, forest officers and administrators, by providing them with immediate information in a handy form and directing them to the chief sources of information on specific products, while it may also be helpful to forest officers when considering the economic possibilities of some product of the forest as yet unused.

The only surprising thing is that it has not been done before.

---

*An Index of the Minor Forest Products of the British Empire : printed and published for the Imperial Economic Committee by H. M. Stationery Office, price *5s. 0d.* net. *5s. 3d.* post free.

SUMMARY

Forest Record, Vol. I, No. 4, Utilization, New Series, on " A Note on Protecting Indian Structural Timbers against Fire, Termites, Borers and Fungi (Rot)."

BY S. KAMESAM.

The several advantages of timber over other competitive structural materials like steel and concrete are well known to most engineers. One of the most important factors that has so far stood in the way of a more intensive use of timber for structures in India has been insufficient durability. In every other civilized country in the world, artificial impregnation of timber with antiseptic chemicals has been found to be imperative for timber to compete with steel and concrete. Before more extensive utilization of Indian timbers can be expected, fundamental information is necessary on the intrinsic relative natural durability of the commercial structural timbers of India, their amenability to pressure impregnation with antiseptics, the best methods of such impregnation and the nature and cost of the wood preserving chemicals that can be employed for protecting wood against fire and against white ants and rot. This Indian Forest Record gives in a very brief form and in a practical manner the results of actual experiments carried out at the Forest Research Institute during the last 14 years. Reference is made to the results that have been obtained with Ascu—a wood preservative that has been evolved at the Forest Research Institute. In view of its apparent efficacy and comparatively low cost it should now be possible for Indian engineers to use most of the various timbers dealt with in the Record for structural purposes.

EXTRACTS

AGRICULTURAL IMPROVEMENT ASSOCIATIONS

In order to stimulate interest in the rehabilitation programme, and to secure community co-operation in the solution of drought and soil drifting problems, agricultural improvement associations have been organized among farmers in a number of districts. Through these associations the systematic adoption throughout various districts of control measures is being effected with greater probability of success than could be expected from the individual efforts of isolated farmers. For this reason special assistance is being given to members of associations to enable them to introduce certain rehabilitation measures on their farms, such as tree planting and seeding grasses for soil drifting control as well as the development of surface water resources.

Considerable progress has been made in the organization of agricultural improvement associations. The total number formed at the end of January 1936, was twenty-nine, of which five are in Manitoba, twenty-three in Saskatchewan, and one in Alberta. These associations have already proved of great educational value.

RECLAMATION PROJECTS

With the object of determining the best methods of preventing soil drifting, and of reclaiming severely drifted land for grain and grass production, reclamation projects have been established at several representative points throughout the drought area. The work on these projects is an extension of the investigational work of the Dominion Experimental Farms, and while not expressly designed for demonstration purposes, will eventually prove useful in this respect. Reclamation of land for farming purposes has been started at Melita, Manitoba, and Mortlach, Saskatchewan. Regrassing reclamation is under way on five areas lying north of Medicine Hat in Alberta, and at Kerrobert, in Saskatchewan.

The reclamation project at Melita consists of an extensive group of experiments, conducted on two sections of abandoned land. These experiments include comparisons of different rotations, of different widths and directions of strips in strip farming, and of different methods of seeding cover crops. Investigations are being started into methods of reclaiming badly drifted land for grain and grass production with tractor-powered equipment. The relative effects of different cultural methods in reducing the tendency of soil to drifting are being compared. Experiments are also planned on the use of fertilizers on drifted soil, and on methods of establishing grasses and clovers on land which has been abandoned for grain production.

Another reclamation project similar in purpose and scope to the Melita project has been established at Mortlach, Saskatchewan.

Regrassing reclamation projects have been started in that part in Alberta lying between Ranges 1 to 14 west of the Fourth Meridian, and extending north from Medicine Hat to Sullivan Lake and Sounding Lake. Within this area a very large percentage of land, which had formerly been brought under wheat production, has

been abandoned because of inadequate precipitation. Much of this land is covered with weeds, such as Russian thistle, sage, and poverty weed, while soil drifting is widespread. The object of the regrassing projects is to determine the best methods of establishing a grass cover which will displace weed growth, hold the light soils against drifting, and furnish grazing for livestock.

Where difficulty is likely to be experienced in securing a stand of grass due to drifting, a suitable fall-sown cover crop is used to hold the soil until the growth of grass is well started. The information which will be secured on these projects will afford guidance for more extensive work throughout this area.

At Kerrobert, Saskatchewan, a total of 87 acres of crested wheat grass has been seeded on eleven farms, with the object of establishing grass for hay or pasture on farm land subject to drifting.

Grass seed is being secured through the Dominion Forage Crop Laboratory at Saskatoon, assisted by the Dominion Seed Branch. Special attention is given by these agencies to propagation and distribution of drought resistant species, especially crested wheat grass. Brome grass and western rye grass are also being used for regrassing while sweet clover and alfalfa are seeded where conditions are suitable.

TREE PLANTING

Tree planting as a measure of soil drifting control is being undertaken under the rehabilitation programme. Shelter belts of trees planted on the margins of farms or large fields, together with intervening hedges, tend to check soil drifting by reducing surface wind velocity. Where such shelter belts and hedges can be successfully established and maintained, the soil drifting problem may be greatly simplified.

Under the provision of the Prairie Farm Rehabilitation Act, certain assistance is given to farmers in establishing shelter belts and hedges. For many years there has been a free distribution of tree seedlings to farmers throughout the prairie provinces from the Forest Nursery Stations.

The Conquest Field Shelter Belt Association, comprising a group of farmers located in the vicinity of the village of Conquest, received assistance during 1935 in planting approximately 85,000 seedlings in some 20 miles of field shelter belts. During 1936 it is proposed to plant about 350,000 seedlings on thirty-four quarter sections.

The object of the Kindersley and Conquest projects is to determine the value of large scale shelter belt plantations in controlling soil drifting. Owing to the extensive nature of this work, the degree of success obtained will profoundly affect the future status of afforestation in the prairie provinces.

Supplies of seedlings for the foregoing tree planting programme have been produced on the Dominion Forest Nursery Stations at Indian Head and Sutherland in Saskatchewan. For the work during 1936 and subsequent years the nursery facilities at these stations have been increased, and extended to include nursery plantings on the Dominion Experimental Stations throughout the prairie provinces. During 1935 preparations were made to supply nine million seedlings for various rehabilitations projects.—(*The Engineering Journal*, May 1936.)

EXPLORING FOR PLANTS IN SOUTHERN TIBET

BY CAPT. F. KINGDON-WARD

Having left Tezpur, an ancient Assamese town on the right bank of the Brahmaputra, towards the end of April last year and crossed the outer range of the Assam Himalaya by the Pankim La at 10,000 ft., I arrived in the dry river valleys early in May. There is only one possible route over the great range in a distance of 300 miles, between the Bhutan frontier and the gorge of the Brahmaputra; east of the Bhareli River savage tribes—Daflas, Akas, Abors and others—bar the way. Travelling leisurely northwards, the Tibetan frontier was crossed by the Se La (14,000 ft.) early in June and Monyul was reached. The rainy season had begun, and this part of the journey over a series of moderately high passes was cold and wet.

Already the alpine flowers were in full bloom. Two dozen species of *Rhododendron* were collected, several of them new to science, and half of them new to Assam. Several Chinese species appeared, still further confirming the unity of the eastern Himalayan and Chinese alpine floras. Certain species of *Primula* occurred in vast numbers, painting the meadows with bright colours, among them the mauve *P. atrodentata*, *P. roylei*, and P. *gamblii*. The last two have each two distinct colour forms, yellow and blue-violet.

In the middle of June, I crossed the snow range by two passes both at a height of more than 17,000 ft. and reached the dry Tibetan plateau at the headwaters of the Subansiri. Here the flora was entirely different. There is no forest, but a few trees grow in the villages where the crops are irrigated. Along the irrigation channels a charming bi-coloured "sibirica" iris grew in masses. The dry rocky slopes are dotted with thorny bushes and scattered herbaceous plants. To the west, the country grows more and more arid, but eastwards the forest reappears even on the north slopes of the Himalayan range itself. So I turned north-eastwards, and crossing two more ranges at 16,000 ft. altitude, reached the sacred valley of Tsari. Incredible numbers of primulas, chiefly a yellow-flowered form of *P. alpicola*, filled the meadows. Many endemic species grow in this country, where the Tibetan rivers leave the plateau to pierce the Himalayas; for example, *Meconopsis argemonantha* (the only known white-flowered species), *Primula cawdoriana*, *Rhododendron hirtipes* and *R. temoense*, *Cyananthus wardii*, *Lilium wardii* and others.

From Tsari, the next range to the north was crossed, and I travelled for eight consecutive days through quite unknown country. The high ranges were all well forested now with conifer forest above and mixed forest below. As the Tsangpo was approached, *Pinus tabulaeformis* became the dominant tree (10,000—11,000 ft.). The Tsangpo was reached at Lilung, thus linking up the new route with my route of 1924. I turned eastwards down the Tsangpo valley and on July 22 reached Tsela Dzong. I was now well into the river gorge country, at the wettest season of the year. Continuing northwards Tongkyuk was reached, and on August 1, I set out to explore the great unknown range of snow peaks which I had reason to believe stretched east and west some 30 or 40 miles north of the Tsangpo.

For the first time for two months I found myself below 10,000 feet. The Yigrong River was explored to its source ; it was followed westwards through a series of magnificent wooded gorges for 18 days. At first the forest consisted of broad-leafed trees, including oaks, laurels, maples and birch, but gradually conifers increased, chiefly *Pinus excelsa, P. tabulaeformis* and *Tsuga brunoniana.* There were snow peaks and glaciers on both sides of the river, but the bulk of the great snow range lay to the south, where there were peaks probably 25,000 ft. high. The source of the Yigrong is in the largest glaciers known north of the Tsangpo.

Recrossing the range by a high pass, I reached the Gyalam (that is, the Lhassa-China road)at Gyamda, about 120 miles east of Lhassa. The country here is much drier again, there is far less forest, and fewer species of trees. It was now the end of August, the height of summer there, and numbers of beautiful flowers were in bloom, including the robust and handsome ***Salvia wardii,*** the half shrubby *Dracocephalum hemslyanum*, with large sapphire blue flowers, *Codonopsis convolvulacea* and species of *Adenophora.*

Continuing westwards, the Lhassa road was followed for two days, and then I turned southwards to cross the unknown country which separated me from the Tsangpo. Crossing the range at 17,000 ft., I reached the Tsangpo sixty miles west of Lilung. The blue-flowered *Onosma waddellii* was in fruit here, also the delightful sand dune plant *Oxytropis sericopetala.* A different route back to the headwaters of the Subansiri was followed, and plants and seeds were collected.

Finally, in October, I once more crossed the great Himalayan range, and varying my route, covered a good deal of botanically unknown country. One of my last finds was a charming new species of slipper orchid (*Cypripedium*). I arrived at the Assam plain again on the last day of October, after a journey of six months.

During that time I had travelled about 1,500 miles, crossed more than twenty passes between 15,000 ft. and 17,000 ft., and explored 600 miles of unknown routes. Many hundreds of species of plants had been collected, including a number of new species, and seed of some of the best for English gardens was obtained. The great snow range north of the Tsangpo was definitely located and followed for a hundred miles.

Botanically, it was possible to recognise three main divisions of the Tibetan flora, which correspond fairly closely with the three stages in the degradation of the plateau. But the observations and collections also emphasise the unity of the Tibetan flora as a whole, and its close similarity to that of Western China and the Himalaya. The Tibetan flora is not of central Asian affinity ; Tibet, western China and the entire Himalaya form a phytogeographic whole, which may be distinguished by the term "Sinohimalayan."—(*Nature*, 2nd May 1936).

FORESTRY AND GAME MANAGEMENT

By Herman H. Chapman, Yale School of Forestry.

Game management is just emerging from a prolonged period of domination by sportsmen interested only in the bag limits and hunting seasons on the one hand, and by politicians who battened on the enforcement of these primitive laws on the other; and now bids fair ultimately to take its place with forestry as a source of conservation and intelligently planned sustained yield, based on an understanding of the biological factors involved in maintaining such a balance, and a recognition by the public that only by giving entire control to men trained in these services can adequate results ever be achieved.

While the technical direction and control of game production in states and nations must rest with game specialists, the immediate problem, where definite areas of forest are concerned, is to secure full co-ordination in the specific management of these forests, so that neither the production of timber crops, nor the protection of watersheds, nor the grazing of livestock, nor the preservation of elk or deer becomes an exclusive aim, in the pursuit of which all other values and interests are ignored.

The general position of the forester, in all civilized countries—a position accorded by the public as the best solution of their problem of adjustment of conflicting interests—gives him practically full control of all the different uses of a forest area. This solution is based on the belief that the forest crop is, in fact, the dominant use, giving the highest value per acre to society, and that other uses must, therefore, be subordinated and correlated to this use.

This solution, however, has not yet been accepted by the American public at large, and the nearest approach to it is in the proposal by the Department of Agriculture that the regulation of game on the National Forests be recognized as a federal responsibility and carried out by the Forest Service.

This theory is also based on a fundamentally important principle, namely, that the administration of any large body of land must be centred in one authority, on an area basis, and not divided between several different authorities on a functional basis. In the former case, the specialists appear as advisors and assistants, while in the latter they have the power to carry out any measure affecting their interest regardless of its effect on the whole administration or on other and perhaps more important interests.

Can foresters be trusted to administer game matters efficiently on forest areas under their charge? This would probably be answered in the negative by most of the game interests at present, in the belief, first, that foresters know too little about game, and second, that they sacrifice game values in an unintelligent manner, in order to secure higher production of commercial trees.

What these game interests do not seem to realize is that the entire profession of forestry is based on the principle of co-ordinated use of all land resources, including agriculture, and not upon the exclusive pursuit of a hobby such as parks, or game, or a single interest like grazing or lumbering; that because of this fact foresters after admitting grazing to the National Forests were the first federal agency to control it

in the public interest; that foresters were the first to detect and endeavour to control erosion resulting from destruction of vegetative cover on other than agricultural lands, and that following a natural path of development foresters were the first to establish modern scientific principles of game management, both abroad and in the United States.

The crux of the situation here will lie in the possible damage by browsing to the reproduction of trees. Already many examples have occurred of plantations decimated by winter browsing of deer. With proper co-ordination of forest management, including the provision for abundant supply of preferred foods (deer do not eat evergreens by choice) and the prevention of ruinous over-population by a regulated kill, it will be possible to raise, not the maximum of wood alone, nor yet the greatest number of game animals, but the maximum crops of both trees and game taken as a whole, on areas on which no one interest is allowed to dominate and destroy the rights and welfare of all others, but which are managed for the greatest good of all, in perpetuity.—(*Journal of Forestry*, February 1936.)

TIMBER TRADE IN THE UNITED KINGDOM

The demand for teak continues to expand and values remain steady. There has been no appreciable increase in the demand for Indian timbers other than teak.

During the 6 months ending June 1936, imports to the United Kingdom of all classes of timber classed as unmanufactured from all sources of supply were valued at £14,404,547 as against a value of £12,727,857 during the corresponding period of 1935. Of these imports hardwoods, hewn and sawn, totalled 386,700 cubic tons valued at £3,364,100 against 363,800 cubic tons valued at £3,058,700 in 1935.

These imports included 22,700 tons of sawn teak from India valued at £429,338 as compared with 18,760 tons valued at £332,350 during the first 6 months of 1935. Figures for imports of teak in the form classed as hewn and for imports of Indian timbers other than teak are not yet available.

Sales through the medium of this office totalled 336 tons and deliveries 312 tons during the quarter.

Imports of plywood to the United Kingdom continue to increase. The Trade Returns show that 6,977,500 cubic feet valued at £2,010,898 were imported during the first 6 months of 1936 as against 6,010,914 cubic feet valued at £1,686,000 during the corresponding period of 1935. Of the quantity of plywood imported British countries contributed 68,235 cubic feet valued at £27,286 in 1936 as against 12,752 cubic feet valued at £5,979 in 1935. The rest was of foreign origin, Finland and Russia between them contributing more than half the total.

There has also been a considerable increase in imports of veneers. The total value of the imports of veneers during the first 6 months of 1936 was £378,340 as against £350,888 during the first 6 months of 1935.

(*Quarterly Report of the Indian Trade Commissioner*, London, April-June 1936.)

INDIAN FORESTER

FEBRUARY, 1937.

THE UNITED PROVINCES FOREST DEPARTMENT (CANNING) BENEVOLENT FUND.

The U. P. Forest Department (Canning) Benevolent Fund was inaugurated in 1932. The Articles of Association are based, with suitable modifications, on the Articles of Association of a similar Fund, which has been in existence for some time in the U. P. Police, and they have been approved by the U. P. Government. The Fund owes its existence entirely to the personal initiative of Mr. Canning, Chief Conservator of Forests, U. P., who took the matter up himself, worked out the details and obtained the approval of Government both to the principle of the Fund and to the provisions of the Articles of Association.

The objects of the Fund, as stated in the Articles, are to relieve distress among the dependents of—

(*a*) members of the U.P. Subordinate Forest Service of and below the rank of Ranger;

(*b*) members of the U.P. Forest Ministerial Service;

(*c*) all others who are members of the permanent non-gazetted establishment in the Forest Department, who die in service or within 12 months of retirement on pension.

The Fund is supported by subscriptions from persons of the categories mentioned above, by donations from other Forest Officers and, subject to certain restrictions, by donations from other persons. Any canvassing for donations, or subscriptions, from persons outside the Forest Service is prohibited.

Membership of the Fund by persons of the categories mentioned is voluntary, but the rate of subscription is fixed, *viz.*, one day's pay per annum. As this is, by one of the rules, deducted from the pay of April, the Fund did not really get into full working order until the

year 1933. For the purposes of this article, therefore, it has been in existence for three full working years only.

The Fund is administered by a Central Committee of Management, consisting of—

The Chief Conservator of Forests (*ex-officio*), President.

One Conservator of Forests nominated by the Chief Conservator of Forests.

One Divisional Forest Officer nominated by the Chief Conservator of Forests, Secretary.

One representative of the U. P. Provincial Forest Service Association, elected annually.

Two representatives of the U. P. Forest Rangers' Association, elected annually.

Two representatives of the U. P. Forest Ministerial Association, elected annually.

This Central Committee meets not less than twice yearly and adjudicates on all claims to benefits and disposes of all business connected with the management of the Fund. In addition to the Central Committee, however, there is in each Forest Division a Divisional Committee consisting of—

The Divisional Forest Officer (*ex-officio*), President.

One member of the Provincial Forest Service, Subordinate Forest Service, or Ministerial Service nominated by the Divisional Forest Officer.

One member nominated by the Forest Rangers' Association.

One member nominated by the Forest Ministerial Association.

The duties of Divisional Committees are, under the rules framed by the Central Committee, to investigate and forward all claims to benefits, to collect and forward subscriptions, to pass and forward the Divisional accounts and to dispose of any other business that may be referred to them by the Central Committee. In this last connection the Central Committee places such funds in the hands of Divisional Committees as it considers necessary to enable them to give immediate relief in urgent cases. The management of the Fund as a whole is, therefore, in the hands of the Central Committee,

but there is no undue centralisation, as all the detailed local work is done by the Divisional Committees.

The Articles of Association give the Central Committee power to make rules to give effect to the objects of the Fund and one of the most important rules made by the Central Committee is that, until the Fund is in a sound financial condition, the Committee shall not allot in benefits more than 50 per cent. of the annual subscriptions and recurring donations plus the whole of the interest on investments, and that the remainder, after allowing for expenditure, shall be invested in Government Securities or Trustee Stock approved by Government.

The membership of the Fund on the 31st March 1936 amounted to 1,323, consisting of—

Forest Rangers	82
Deputy Rangers, Foresters and Forest Guards ..	932
Clerical Staff	197
Menials and others on the permanent establishment	112

The amount of relief granted has naturally increased annually in the early days of the Fund. In the year ending 31st March 1934 Rs. 200 only were granted. In the next year the amount was Rs. 638 while in the year ending 31st March 1936 the amount granted was Rs. 1,649, the number of cases dealt with since the start of the Fund having risen to 23 and the relief granted varying from Rs. 20 per mensem to Rs. 4 per mensem according to the rank and pay of the deceased. Commitments for the current year are heavier still and it is obvious that, until the resources of the Fund have been built up, benefits cannot be continued for ever, but that the period for which they are given will have to be limited by the funds available. The members of the Fund on the Central Committee fully realise this and during the current year all cases have been examined on their merits and further relief discontinued in some of the less needy cases. In no case, however, has relief been given for less than two full years and in cases of real need it is being continued for longer, while there is every hope that as the resources of the Fund are built up, it will be found possible to continue the relief for longer in all cases. In

this connection, a tribute is due to the good sense of the members of the Fund in recognising the position.

That the management of the resources of the Fund has so far been carried out wisely is shewn by the balance sheet on 31st March 1936—the latest date up to which the accounts have been audited. On that date the position was as follows:

		Rs.	a.	p.
Investments	.. ..	4,127	1	0
In the Post Office Savings Bank	..	735	11	3
In current accounts of Committees	..	1,352	5	11

Income for the year 1936-37 is anticipated to be at least Rs. 3,000, and at its first meeting during the current year, the Central Committee decided to invest another Rs. 1,000. This brought the amount invested to over Rs. 5,000 by the end of three full years' working. If the management of the Fund is carried out on these careful lines for the next few years, the financial position should become strong enough to enable the scale of relief to be increased either in amount, or in the length of time for which it is given, or possibly even in both ways.

The maintenance of the accounts of the Fund entails considerable work on all concerned, but it is a pleasure to be able to record that the Ministerial staff does the whole of this voluntarily, except for a small honorarium paid to the staff of the division whose Divisional Forest Officer is also the Secretary of the Central Committee. This means a very great deal of extra work for his staff and the small honorarium is amply earned. With that exception, however, all the work in connection with the Fund is done entirely voluntarily.

The Fund meets a long-felt need and, in the short time during which it has been in existence, it has already been able to bring relief to many hard cases, for which but for its existence nothing could have been done. As noted at the beginning of this article, the Fund owes its existence entirely to the personal efforts of Mr. Canning whose name it bears and the whole of the Forest Department in the United Provinces has good reason to be grateful to him for laying the foundations of a Fund which should be of lasting benefit to the dependents of our staff.

NOTE ON SOIL EROSION IN THE PUNJAB

By R. Maclagan Gorrie, D.Sc.,

Silvicultural Research Division, Lahore.

Previous reports.—Erosion in the lower foothills throughout the whole width of the province, from the Jumna to the N.W.F.P., has long been a subject of concern to forest officers as is shown by the following reports:

1855—Rules for Conservancy of Forests in the Hill Districts of the Punjab.

1879—B. H. Baden-Powell's Report on Hoshiarpur Chos.

1882—Forest Settlement Report for Murree and Kahuta (Rawalpindi).

1880—90—Punjab Annual Forest Reports. By Ribbentrop, Moir and Bailey.

1900—Punjab Chos Act.

1928—Report on Denudation and Erosion in the Low Hills of the Punjab. L. B. Holland.

1928—Royal Commission on Agriculture, pp. 251 and 267. These apply to the whole of India but more particularly to the Punjab as this has the highest grazing incidence of any province.

1929—Denudation in the Punjab Hills. B. O. Coventry. (*Indian Forest Record*, XIV, II.)

1930—Erosion in Punjab. Holland and Glover in *Punjab Engineering Congress*.

1932—Report of Punjab Erosion Committee.

1935—Siwalik Erosion. A.P.F. Hamilton in *Himalayan Journal*, reprinted in *Indian Forester*, June 1936.

1936—Torrent Action Interferes with Canal Efficiency. R.M. Gorrie. *Current Science*, August 1936.

1936—2nd July. Punjab Government Conference on Erosion.

Extent of eroded areas.—Serious erosion is confined to the belt of foothills and sloping ground formed by the main Himalayan lower

slopes, the Siwaliks, and the other outlying rocky hills typical of Gurgaon in the east and the Salt Range in the west. It thus includes the greater part of the following civil districts:

Gurgaon, Ambala, Hoshiarpur, Kangra, Gurdaspur, Sialkot, Gujrat, Jhelum, Shahpur, Rawalpindi, Attock and the Indian States of Suket, Mandi, Bilaspur, Chamba, the Simla Hill States, Sirmur, Patiala, Kalsia, Morni and Kashmir.

At a rough guess, say, 35,000 square miles, in a strip 60 miles broad between the Jumna and the Chenab, widening to 120 miles broad between the Jhelum and the Indus, with Gurgaon as an isolated and separate area in the south-east corner.

The effects of erosion will of course make themselves increasingly felt outside this actual erosion belt because of the serious effect it is having upon canal water supplies, and the menace to the safety of hydro-electric plant, both of which activities affect the welfare of practically the entire province.

Forest conservation has to some extent checked erosion, but even with the best intentions the earlier forest settlements have failed to forestall the progressive deterioration which has inevitably taken place in face of persistent heavy grazing. In any case the area under the direct control of the Forest Department, namely 5,184 sq. miles, represents only 5 per cent. of the total land area of the province, and of these forests only about half are in the severe erosion zone of the lower hills, the remainder being either in the high hills or in the canal colonies of the plains. There thus remain well over 30,000 sq. miles of the foothills over which the Forest Department has no control and no other department of Government has so far attempted any form of soil conservation work.

Data available.—The Irrigation Branch has been collecting data on the silt carriage of the Punjab rivers for many years past, and the question is of vital importance in canal efficiency. For instance, the enormous load of silt largely derived from Jammu and Gujrat foothills and carried by the Jhelum river, has decreased the carrying capacity of the Upper Jhelum Canal by 40 per cent. even with the installation at great expense of several silt ejectors. The Irrigation Research

In stitute is now working on run-off figures for the Ravi river by which it is hoped to find statistical proof of the opinion widely held by canal officers, namely that the winter discharge of this and other Punjab rivers has definitely deteriorated since the earlier irrigation canals were built.

Figures of torrent intensity have been published (Gorrie, *Current Science,* August 1936) giving actual run-off in terms of cusecs per sq. mile for 3 different types of cover in the Pabbi foothills, *viz.* (*i*) 100 cusecs for eroding land reclaimed by afforestation and construction of bunds, (*ii*) 600 cusecs for similar land under a passive regime of protection against grazing, (*iii*) 1,600 cusecs for similar land persistently overgrazed until the plant cover has been virtually destroyed.

A survey of erosion conditions has been made (May-June 1936) in the Uhl catchment area which supplies the water power for the Jogindernagar hydro-electric plant. In this catchment 150 sq. miles of very steep hills 6,000—16,000 ft. elevation earns only 3 pies per acre for Government in land revenue and grazing fees, but carries a responsibility of Rs. 730 per acre invested in the hydro-electric project which depends upon it for its water. The ground falls into 4 belts, (*i*) Valley Bottom Farm Belt, (*ii*) Forest Belt 8,500—11,000 ft., (*iii*) Alpine Pasture Belt 11,000—13,000 ft. and (*iv*) Snow Belt, mostly rock, glacier and snow field. The survey shows that out of 18,000 acres in (*i*) 97 per cent. is in bad erosion condition, much of it serious; in (*ii*) 35 per cent. of the 27,000 acres is in poor condition for catchment purposes; in (*iii*) 25 per cent. of the 20,000 acres is eroding to an appreciable extent. The chief causes of erosion are: (*i*) bad cultivation on unterraced or poorly terraced land and extension of potato cultivation, (*ii*) heavy grazing of home and migrant flocks in the vicinity of villages, (*iii*) seasonal concentrations of migrant Gaddi flocks on the alpine migration routes.

In Ambala and Hoshiarpur farm lands below the Siwaliks much land has passed out of cultivation owing to the failure of existing wells. Geologists admit that deforestation of the Siwalik slopes is a contributory cause in the lowering of the underground water-table

which in some places has dropped beyond the depth at which well irrigation is feasible.

In the Jhelum District in 36 years 50,000 acres of cultivated land have been destroyed by the action of Salt Range torrents before they join the Jhelum river.

American figures of run-off and erosion intensity for various types of soil, slope and plant cover are directly applicable to Punjab conditions and have been used to some extent in press propaganda articles, *e. g.*, 150 tons of soil per acre per annum lost from potato cultivation on steep slopes with ridges running downhill. The Irrigation Research Institute is co-operating with the Silviculturist, Punjab, in making a suitable type of run-off measurement tank and it is hoped to produce data for Punjab conditions in the near future.

Areas worked in and results to date—

Pabbi (*Gujrat district*).—Counter-erosion work has been done spasmodically since 1879 when 38,000 acres were constituted a reserve, primarily for the protection of the main railway line and the G. T. road to the N. W. F. Latterly, however, the interference of the Pabbi torrent with the working of the Upper Jhelum Canal has become much more important than the other two factors, although the Forest Department programme has not been modified to meet these changing conditions and the area so far reclaimed is of little direct benefit to the Upper Jhelum Canal management. Up to date about 3,500 acres have been reclaimed by afforestation chiefly with *Prosopis glandulosa*, and the building of earth and stone bunds to check ravining.

Hoshiarpur.—The devastation caused by the Siwalik chos reached a peak about 1897, and the Chos Act of 1900 led to the expulsion of goats from the middle altitudes of the southern Siwalik face. This area has recovered most strikingly and is now a sound source of revenue by grass cutting. Unfortunately the lower fringe of the south face and the whole of the inner Jaswan Dun did not come within this Act and these areas have deteriorated seriously since. Closures amounting to some 60,000 acres on the south face have, however, been arranged by Hamilton during the last two years' working

to get co-operation from the villagers largely through discussion and persuasion. This work is to be extended into the Jaswan Dun.

Ambala.—About 44,500 acres in this district come under the Chos Act, but they have not been so well protected and are in rather worse condition than Hoshiarpur. Recommendations for counter-erosion work were made in Gorrie's Working Plan for Kalsia State Forests 1927 but they have not been carried out. Parts of Kalesar R. F. and Kalsia and Morni estates have been well protected and are in good condition, but the foothills elsewhere are in a terrible state. The Morni forests have been protected after a fashion since 1888 but protection has recently deteriorated and this area is overrun with goats and cattle.

Gurgaon.—Some 8,000 acres closures were secured in village common grazing lands about 1924 by allowing a remission of village land revenue to the village co-operating. The forest staff is a forest ranger and a few guards attached to the civil and as the area is far from any other regular forest work it only receives irregular examinations by gazetted forest officers. These closures have, however, been a good object lesson, and a wider extension of this policy is under consideration. The type of country here is not deep ravines but completely denuded rocky hills which contribute sudden and heavy floods to the cultivated lands below.

Kangra.—This district is the most heavily populated of the Punjab agricultural districts and is suffering tremendous soil losses and floods which affect the larger canals through the contribution of the Beas river. The grazing problem is complicated by the presence of immense numbers of Gaddi goats and sheep which have migratory rights and also large numbers of Gujars who have settled in the district with their buffaloes. Nothing has yet been done apart from an ineffectual tax on migratory flocks, but a report has recently been submitted framing comprehensive proposals for demonstration areas in which grazing control and better methods of cultivation can be shown. A special case is the Uhl valley in Chota Banghal which forms the catchment of the Jogindernagar hydro-electric plant; a detailed survey of erosion conditions in the 150 sq. miles of catchment

has been made in 1936. Recommendations have been made for drastic curtailment of migrant goat grazing and for the acquisition and reforestation of the steeper slopes now cultivated; these are now under consideration of Government.

Jhelum Salt Range.—No active counter-erosion work has been undertaken so far, but during the last two years it has been shown that afforestation with mesquite (*Prosopis glandulosa*) and *phulai* (*Acacia modesta*) is quite feasible, contrary to the previously held opinion of forest officers. The whole range is terribly arid and even the reserves are deteriorating rapidly. The only areas in which definite improvement has taken place are those village commons which have been partitioned and taken up intensively by individuals for the building of contour walls and the restriction of grazing. A demonstration project costing Rs. 20,000 and comprising all possible phases of counter-erosion work in the upper reaches of the Sauj nala has been recommended by the Erosion Conference for a grant under the Government of India Rural Reconstruction Funds but so far nothing has been allotted.

Other districts.—The remaining foothills districts from the Jumna to the Frontier are all suffering more or less seriously from erosion, but very little active work has been attempted. The following areas are affected :

Gurdaspur, Gujrat, Shahpur, Attock, the Murree foothills, the Kalachitta and other low hills in the neighbourhood of Rawalpindi along the north and west fringe of the Salt Range.

Measures taken to stop erosion.—Until recently the Punjab forest officers have advocated closure to grazing as the only feasible means of restoring the plant cover to its natural conditions and thus reducing the run-off and loss of soil. This of course is still the main line of attack, but considerably more can be done if the various phases of misuse of land are taken up under improvement schemes which deal with bad agricultural as well as bad grazing methods. Much of the erosion loss occurs in areas where so far no department of Government has made itself responsible for teaching and improving local methods, and in projects recently outlined the need for close co-operation between the Forest, Agriculture, Veterinary, Animal

Husbandry and Revenue staffs has been emphasised. The main lines of attack are—

I. Develop fodder resources for local livestock by means of :—

(*a*) Rotational closures.

(*b*) Partition of shamlat.

(*c*) Panchayat management.

(*d*) Intensive improvement of natural grasslands, including "gully plugging" to stop active erosion.

(*e*) Develop tree fodder supply.

(*f*) Develop green fodder crops and silage.

(*g*) Research on correct grazing incidence.

(*h*) Restrict non-right holders and immigrants' livestock.

II. Improve standard of cultivation by means of :—

(*a*) Better terracing and levelling of fields.

(*b*) Discourage downhill ridging for potatoes.

(*c*) Find good legume or grass crop to sow on fallow and plough in as green manure.

(*d*) Encourage use of compost manure.

(*e*) Control nautor grants (permission for fresh cultivation) and refuse all for steep slopes.

(*f*) Consolidation of holdings.

(*g*) Co-operative tree planting.

(*h*) Use of live hedge plants to replace thorn cutting.

(*i*) Contour drains in tea gardens and orchards.

(*j*) Stream training to reclaim cultivable lands along torrent channels.

NOTE ON THE RESULTS OF AFFORESTATION OF JUMNA, CHAMBAL AND OTHER RAVINES

BY D. L. SAH, I.F.S., D.F.O.,

Afforestation Division, Cawnpore.

I. *History of afforestation.*—It was generally known that there are extensive waste and ravine lands along the Jumna and Chambal rivers. The question of utilising these waste lands was the subject of a report as early as 1879, but no definite action was taken in the matter for nearly 30 years. In 1890, in his report on Indian Agriculture Dr. Voelker laid down the necessity of creating fuel and fodder reserves. The subject was revived in the United Provinces Government resolution No. 348, dated 20th August 1912, when a Forest Officer was deputed to make a survey of the most promising areas. His opinion as to the highly promising nature of the country was embodied in a report to the Conservator of Forests, Eastern Circle, wherein he advocated the acquisition by Government of the entire ravine area to the extent of some 100,000 acres, and the management of these areas primarily for fodder. In view of the above report and the recommendations of the Conservator of Forests, Eastern Circle, a committee of officials and non-officials was appointed in 1913 to examine the various points raised in the report and to submit recommendations to Government. This committee recommended that it is most desirable that any measures considered practicable be undertaken to increase the productiveness of the ravine tract for grazing purposes and for the production of fuel, but it was against the application of the Land Acquisition Act on any extensive scale when introducing the management of ravines in the Etawah District. In 1914, *vide* G. O. No. 175-L of 30th September 1914, the Principal of the Agricultural College, Cawnpore, and a Forest Officer were appointed to report on the possibilities of an extended campaign of ravine reclamation and prevention of erosion as approved for the Etawah District and the scope offered in this direction for useful famine

works. They recommended—

(1) the recruitment of a sufficient staff before any further reclamation could be undertaken ;

(2) the immediate transfer of certain forest blocks to the Afforestation Division, which appeared most suitable for reclamation, whenever Government was prepared to extend operations ;

(3) Government should instruct district officers to ascertain definitely the willingness or otherwise of the landholders in the blocks recommended for reclamation (*a*) to reclaim and afforest their ravines at their own cost under the management of afforestation officers, (*b*) to hand over their land for reclamation at the expense of Government on terms similar to those proposed to the Etawah zamindars, (*c*) to lease their land to Government, or (*d*) to sell their land. If the zamindars were willing to adopt any of these courses, the writers recommended that definite arrangements should be made so that when a sufficient staff had been trained the work of reclamation could begin without delay. If there was any landholder with whom no settlement could be effected, the writers thought that, in view of the importance of the object to be attained, Government should acquire the land.

2. *Aims of afforestation.*—Originally it was only intended to improve the ravine lands for grazing purposes and for the production of fuel, but various objects of management as given below were laid down by Government orders or resolutions that were issued at intervals from 1912 to 1920 :

(*i*) To stop soil erosion in ravines, *i.e.*, the scouring out of the beds of ravines and the washing down of their banks.

(*ii*) To stop further extension of ravines inland.

(*iii*) To prevent good soil being washed off the uplands and carried away down to the rivers.

(*iv*) To retain the rainfall in the soil and thus raise the water level.

(*v*) To make fodder reserves by growing grass (hay) for the local villagers and for export to other localities in famine years.

(*vi*) To provide good pasturage.

(*vii*) To provide firewood for the local villagers.

(*viii*) To grow firewood for export and sale at a profit.

(*ix*) *To grow valuable timber for sale at a profit.*

(*x*) To provide tan bark for the Cawnpore tanneries.

(*xi*) To break down the ravines with the object of making them suitable for agriculture or for the production of fodder.

(*xii*) For financial profit.

(*xiii*) To encourage zamindars to protect and manage their own ravines.

(*xiv*) As famine relief works.

Besides the above there were others too, such as creation of breeding ground for cattle, improvement of soil, etc.

3. *Natural vegetation in ravine land.*—The natural vegetation of the ravine land has been destroyed by uncontrolled cultivation wherever the soil is fit for this, and by uncontrolled grazing, reckless destruction and by fires. Large areas are now almost treeless, but the natural vegetation has undoubtedly been forest and is still forest except in *kanker* and *usar* soils. The vegetation is mostly of a xerophytic type and consists of small trees, thorny bushes and grass: the following being the most common and characteristic:

Trees	*Large shrubs or small trees*	*Small bushes*
Prosopis spicigera (*cheonkar*)	*Balanites aegyptiaca* (*hingot*)	*Capparis aphylla* (*karil*)
Acacia leucophloea (*reonj*)	*Dichrostachys cinerea* (*khairi*)	*Capparis horrida* (*hins*)
Azadirachta indica (*neem*)	*Zizyphus jujuba* (*ber*)	*Salvadora oleoides* (*pilu*)
Acacia catechu (*khair*)		*Adhatoda vasica* (*arusa*)
		Zizyphus spp. (*ber*)
		Carissa spinarum (*karaunda*).

Acacia arabica is also found fringing the rivers, nalas and other moisture localities, but seldom occurs in the arid ravine zone.

More important than trees and shrubs are the grasses. The most common grasses in the ravine land are *Aristida hystrix* and

Aristida depressa, both of which are practically worthless and are known as "*safed lampa.*" The more valuable grasses do exist even in the most heavily grazed localities under the shelter of thorny bushes or in patches of uneven ground inaccessible to cattle.

4. *Past management.*—The work of afforestation of the Jumna and Chambal ravines was started in 1912 and continued for nearly 15 years during which period 16,650 acres of ravine land was planted with timber and fuel species. But towards the end of 1927 the work of planting was given up on financial grounds and also due to the fact that the timber species in the newly-planted ravines, though they started very well, did not come up to original expectations. When afforestation was in full swing the working of soil was done thoroughly and systematically. Big bunds were made on the bottoms of some prominent ravines to store up water to keep the surrounding soil moist. Small earth dams were also made at the heads of small ravines to stop a sudden run-off of surface water and to stop further erosion there. Of all the indigenous trees of the area babul seemed the most attractive by reason of the demand for its bark for tanning and for fuel, but as many as 42 other species were also tried. Both planting and direct sowings were attempted by the ridge and ditch method.

5. *Area statement.*—The following statement shows the area afforested and the cost of afforestation:

District.	Area afforested.	Total cost incurred up-to 1935-36 (excluding overhead charges and cost and repair of buildings)	Expenditure during the last 5 years (excluding overhead charges and cost and repair of buildings).				
			1931-32	1932-33	1933-34	1934-35	1935-36
	(Acres.)	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Etawah ..	11,992	4,38,358	8,318	5,943	5,657	4,917	3,929
Agra ..	1,926	65,748	1,509	94	124	59	10
Jalaun ..	2,103	68,132	472	211	160	103	83
Cawnpore ..	350	27,602	322	210	200	148	318
Lucknow ..	279	9,204	49	25	2	..	..
	16,650	5,99,044	10,670	6,483	6,143	5,227	4,340

NOTE:—(1) Of this area, 1,255 acres have since been handed over to the owners.
(2) This expenditure does not include overhead charges and cost and repairs of buildings or roads.

The area of waste land (including unculturable land, *usar*, ravine areas and land occupied by roads and buildings, etc.) in the United Provinces is more than 8 million acres. The ravine area in the Etawah District is about 1,20,000 acres, in Muttra about 13,204 acres, and in Agra about 1,30,000 acres. It is estimated that the area of ravine land in the United Provinces is about 10,00,000 acres. I regret that the correct area of ravine land could not be had from the Provincial or the District *Gazetteers*, nor from the Statistician to the United Provinces Government.

6. *Results of afforestation.*—The afforestation policy started with so many different objects of management that complete success was hardly to be expected. Some of the objects overlap one another or are consequential of one or the other, but the three primary objects were—

(1) to grow firewood and valuable timber for sale at a profit;
(2) to improve the pasturage and tree growth in the ravines and thus to establish fuel and fodder reserves;
(3) to prevent the further erosion of ravines and to check the extension inland of ravines.

(1) *Timber*—

The object of growing valuable timber was really considered as one of the most important because it was on this that the chances of making the afforestation scheme pay were counted. The attempts so far made to grow valuable timber have been made with many species of trees and have been failures as the trees do not grow to a large size on account of the adverse climatic conditions and the *kankar* that is found in the sub-soil in many parts of the ravine land. Though most of the species of indigenous trees are gregarious, yet their only chance of developing in such an unfavourable habitat is, according to Mr. Marriott, to stand alone or in pairs or trios—free from excessive root competition. Whatever the reason, it is almost certain that the ravines will not produce a crop sufficiently dense to pay for its formation.

Fuel: It is now also definitely known that artificial plantation in the ravines or the production of fuel alone is financially unproductive

fitable. In fact it was never expected that the afforestation scheme could be made to pay out of sales of firewood.

(2) *Improvement of fuel and fodder*—

Although the indigenous forest is not worth much, it would be a mistake to overlook it altogether, for it is only these indigenous trees that are likely to do any good in these ravine areas. As far as village requirements of fuel are concerned it can be safely assumed that the indigenous trees will more than suffice. The protection of these species from heavy grazing and reckless destruction has not only improved their growth but has also largely contributed to their propagation by natural regeneration. In fact there is hardly an acre where simple protection has not brought about the appearance of some of these trees.

Fodder: Where closure is applied to any ravine area or when the grazing is controlled, the more valuable grasses oust the *safed lampa* and spread rapidly as a rule. After a few years of closure all the ground, except patches of exposed *kankar*, becomes well covered with fodder grasses—

Andropogon foveolatus	.. *murjhaina.*
Andropogon pertusus	.. *chhoti jergi.*
Apluda aristata	.. *bhanjura.*
Brachiaria ramosa	.. *kirwai.*
Chloris barbata.	
Chloris roxburghiana.	
Chloris virgata.	
Cymbopogon parkeri	.. *katauna.*
Dichanthium annulatum	.. *bara jerga.*
Elaeusine flagelifera	.. *ghur dub.*
Eriochloa ramosa.	
Hetropogon contortus	.. *kala lapa (lampa).*
Ischaemum rugosum.	

When, however, one of these closed areas is reopened to unrestricted grazing the reversion to the original worthless *safed lampa* and the almost complete disappearance of the useful fodder grasses is very rapid.

(3) *Prevention of erosion and expansion of ravines.*—

Experience has shown that controlled grazing or closure to grazing has produced excellent fodder reserves and has alone been enough to attain the object of stopping soil erosion in ravines and their extension. It is the grasses that really matter—not trees— as a preventive of surface run-off of rain water and therefore of soil erosion. Observation has shown that wherever there is a thick crop of grasses, irrespective of the presence of shrubs or trees, no fresh erosion is visible in such areas, while fresh erosion and slips are quite common in the unprotected areas where the ground is bare of grasses.

7. *Conclusions.*—(1) Ravine management and prevention of extension of erosion in ravines are simply questions of control of grazing and improvement and preservation of grasses. Closure to grazing or controlled grazing enormously increases the quantity and quality of fodder grasses and indigenous trees or shrubs, and encourages their natural regeneration and effectively prevents soil erosion and the extension of ravines. But unless the blocks taken up for afforestation are continuous or are very large, the protective effect is small and local.

(2) It is usually mere waste of money to attempt to introduce valuable timber or fuel species as, due to various adverse factors, the trees do not grow to timber size or to a sufficiently dense crop, and because by simple protection (either departmentally or by co-operative societies or village panchayats) and almost without any expense it is possible to improve the indigenous fuel species and encourage their natural regeneration.

(3) Whenever a protected area is opened to continuous or unrestricted grazing, the reversion of the indigenous trees to their original state and the reversion to the original worthless *safed lampa* and the almost complete disappearance of the useful fodder grasses is very rapid.

(4) Regulation of grazing and cultivation at and around the heads of the ravines is absolutely necessary to prevent the extension of ravines. The heads of ravines are often outside the boundary of the land taken up for afforestation and sometimes in the middle of

the cultivated land. It was the difficulty of dealing on a large scale with such places that caused Government practically to give up the idea of ravine reclamation as early as 1920 (*vide* G. O. No. 1503/XIV-142 of 9th September 1920).

(5) The construction of large masonry bunds to store up water for keeping the soil moist does not justify the expenses involved. However, small earth dams made at the heads of ravines to stop surface run-off of rain water are useful in preventing soil erosion and in silting up of the shallow, newly-formed ravines.

(6) The area taken up for afforestation is so small and scattered that it can hardly be expected that it will have any appreciable effect on the erosion of the extensive ravine areas outside the small blocks taken up for afforestation, but erosion has almost completely stopped in all blocks that have been successfully afforested.

FORESTRY IN THE U.S.S.R

By H. P. W. D.

The following résumé of the development of forestry in the Soviet Union since the Revolution is, for the most part, a summarised translation of the opening section of Lyes Na Sluzhbu Sotsialisto-cheskomu Stroitelstbu, an official publication of the All-Union Institute of Forest Culture and Forest Melioration. No responsibility is taken by the translator for the political views expressed, which, as may be expected from such a source, are rather highly coloured. The report was intended evidently for technical readers rather than the general public, and not for foreign consumption; so we are justified, I think, in regarding it as a fairly faithful account of the main developments of forestry under the Soviet Union.

Naturally enough, the writer of the report glorifies the exploits of the new regime and sees every material advance—however common to the world in general—as the peculiar triumph of communist ideology. When due allowance is made, however, for the exuberance of the new broom, we cannot fail to be struck by the very considerable

progress that seems to have been made in forest organisation and research over a vast territory—comprising, we are told, no less than one-third of the total forest area of the world. Whatever our attitude to the social and political issues at stake, we cannot, as foresters, afford to remain entirely oblivious to the increasing application of scientific principles to such an enormous tract of forest.

The programme of the first Five-Year Plan, we read, was not confined to Industry. It applied, in an equal degree, to Agriculture, and to Forestry. Hand in hand with the completion of gigantic engineering and constructional achievements such as Magnetostroi Dnieproges, Kugnetstroi, the Gorki Automobile Plant, the Stalingrad Tractor Factory, etc., Soviet Agriculture acquired a new mechanical technique. More than 2,500 mechanical tractor stations were established throughout the Union and the whole face of the country was changed. With the liquidation of the kulaks (well-to-do peasant proprietors), the small holdings gradually vanished and a new system of State and Collective farms arose. By 1933 over 60 per cent. of the peasant holdings had been collectivised and about 80 per cent. of the arable land of the Union was in the hands of either State or Collective farms. This achievement "completed the foundation of socialist economics and finally established Agriculture as well as Industry on a basis of planned social economy."

"The victories of Socialism in the U. S. S. R. were the direct result of the policy inspired by Lenin in the party, and achieved in the merciless struggle, not only with the Bourgeois theories of Counter-revolutionary Trotskyism, regarding the impossibility of establishing socialism in one country, and the inevitability of the return of Capitalism, but also with the opportunism of the Right, which tried to undermine the policy of Socialist attack by direct capitulation before the Kulak and Bourgeois elements."

However that may be, the particular importance of Forestry (including the timber-working industries) in the Socialist programme was shown in its share in the defence of the Revolution.

As it was found impossible during the course of the Revolution to exploit the coal and oil fields occupied at the time by White forces,

the demand for fuel became acute, and could only be supplied by local forms of fuel, among which firewood as most accessible and "easily appropriated" was easily first.

The fuel question was indeed so serious that it actually nearly brought the revolution to a standstill at the most critical moment in the struggle after October 1918. In one of his party manifestos Lenin wrote: "The fuel crisis threatens to destroy all the Soviet work. The workers are in flight through cold and hunger. The trains bringing corn have come to a standstill. A catastrophe is impending simply from lack of fuel."

However, "the crisis, threatening to throttle the youth heroically struggling for the dictatorship of the proletariat" was surmounted by the active measures of Lenin, who organised the extraction of fuel from the forests of the country upon the most intensive lines possible, through GLAVLESKOMA, a department specially constituted for the control of the timber and fuel resources of the State.

The fuel crisis did not, however, distract the attention of Russia's new rulers from the necessity of adopting a definite silvicultural policy. The Forest Act, promulgated on 27th May 1918, established the lines of the new Social Forestry, and a resolution of STO (the People's Labour and Defence Council) of 27th July 1920, inaugurated a new system of Fire Protection in which the local population was organised and trained on military lines through the Direction of General Military Instruction to prevent and to combat forest fires.

One of the first and most important steps in the new Socialist State was the nationalisation of the forests, most of which, under the Tzarist regime, had belonged to private persons. Needless to say this task was not facilitated by the former owners, who, if they survived at all, had hidden or destroyed their title-deeds and all other documentary information relating to the area and location of their forests, as well as all details as to their composition, yield, etc. The first attempt at a census and rough valuation of the National Stock of Forests was made in April 1918 and this has formed the basis of all subsequent forest settlement. Formal organisation (*i.e.* under regular working plans) of the national forests was commenced later and is still

in progress, at a "tempo," we are told, far exceeding that of pre-revolutionary times. As an example of the vast speeding up in the work imparted by the revolutionary spirit we learn that while the Tzarist Government, in the period from 1842 to 1916, succeeded in organising hardly 10 per cent. of the Government forests and in surveying 26 per cent. from 1924, Forest Management under the Union made enormous strides, and in the first Five-Year Plan the task was undertaken of organising 152 and surveying 194 million hectares in forests of industrial importance.

The report here digresses to point a moral in favour of Socialist as against Capitalist achievement, which appears, under the circumstances, hardly justified, for a similar acceleration in the organisation of national forests in the last twenty years is equally marked in Capitalist countries, and is due rather to the general increase in scientific knowledge and experience, and to a higher level of training of the Forest staff.

At the end of the reconstructive period a simultaneous valuation was made of the whole forest reserves of the Union under the heads of area, category, distribution of species and growing stock, area of yearly felling and of artificial regeneration. This was the first step towards the organisation of forestry on an all-Union scale.

The supply of the timber demands of the building industry of the country was one of the fundamental problems which forestry had to face. This was provided for in the Forest Act of 1918, and in 1922 was formed an Inter-Departmental Commission for the Distribution of Forest Territory to guarantee the respective needs of each branch of industry. Subsequent legislation apportioned the responsibility for the forests to the District Commissions, and a commencement of long-term exploitation on a planned basis was made. The value of planning in forestry is self-evident, and not unknown in Capitalist countries. The report, however, sees in it a particular example of Socialist Reason manifested in contrast to the enormities of the Old Regime, with their uneconomic localised fellings and waste of mature material elsewhere. All this has been changed under the beneficent operation of the Dictatorship of the Proletariat.

The stormy tempo of Socialist development under the first Five-Year Plan brought about a gigantic growth in the timber and wood-working industry, the output of which in the three first years rose to 194 per cent. in minor, and 183 per cent. in major produce.

In spite of this expansion, however, the demands of the Social Building Programme considerably outran the supplies, and this hiatus still exists, and must be " liquidated " by every effort of the Government and people under the second Five-Year Plan. It is hoped to accomplish this by more rational employment of labour and mechanisation, proper organisation, and more intelligent direction of labour and production.

The satisfaction of the needs of the local population was a primary consideration of the new regime from its earliest commencement, and was accomplished in two ways: by the setting aside of special forest areas for the use of local communities, and by the granting of privileged rates for forest produce to cultivators.

Communal forests had existed even in Tzarist times in the south of European Russia (R. F. S. F. R.), but not in the north. The claim of the local communities to these forests was now reaffirmed in the south and an allotment of similar communal areas made in the north. In 1926 further enactments were passed considerably extending the areas of communal forests, even, to a great extent, at the expense of the forests of general importance. In 1933 the total area of forest in the hands of local communities in European Russia amounted to 35 million hectares. No details are supplied as to the extent of the privileges and powers of utilisation allowed to the individual members of the local communities, but, that these are strictly limited, and carefully controlled, may be inferred from the fact that, although primarily under the village soviets and district committees, they are under the general direction of the Soviet NARKOMZEM (National Land Committee), which, in 1931, placed these forests under a systematic regime of controlled felling and guaranteed regeneration.

The needs of the local population are also met to some extent from Government forests, chiefly by free grants to Kolhoz (Collective farms) and also to individual members. The right of collection of dead wood

is allowed by the Forest Code to the poorest classes, not apparently free, but at reduced rates, and so long as they can prove genuine indigence. According to a decree of SOVNARKOM (Council of People's Commissiaries) of 1930, 50 per cent. of the produce of local forests is allotted to the collective farms for construction and repair of communal buildings and other needs of collectivist members, and the remainder is distributed to the poorer classes of manual labourers.

As the chief source of revenue of the Soviet Union since its foundation, the export of timber has played a very important part in the industrialisation of the country. Some idea of its importance can be gained from the figures of revenue for the year 1929-30, when *the timber export amounted to 176 million roubles or (assuming* 9·45 roubles to the £) £18 millions. It will be remembered that at the time there was a considerable outcry in the British Press, and no doubt also elsewhere, about the dumping practices of the Soviet, through which their timber was underselling that of their competitors at uneconomic prices. Coupled with that, there appeared articles describing the conditions of forced labour in the timber camps throughout the Union. According to this official publication, however, these reports were, like Mark Twain's death "greatly exaggerated," since such practices are "foreign to Socialist principles" and were no other than "a smoke barrage behind which Capitalism tried to cover its real purpose—the destruction of our constructive Socialism."

Forest exploitation under the Tzarist regime was necessarily primitive, as it was also to some extent even in more advanced countries at that time. The general advance of civilisation has since led to the adoption of improved methods and mechanical facilities almost everywhere, and the forestry of the U. S. S. R. has not lagged behind. In the matter of implements and lines of transport considerable progress has been made in late years, and with the establishment of MLS (Mechanical Forest Stations) throughout the Union this process is speeding up. The first Five-Year Plan started with 90 forest tractor units, which, by 1932, has risen to 686. Meanwhile the "rationalisation of export" is being achieved by various kinds of artificial roads, *e.g.*, ice-ways, sledge-ways, rope-ways

and monorail systems, and a vast series of saw-mills is being installed, equipped with all the refinements of modern technique. Not only this but wood-working plants of modern design are dealing with new forms of production, such as artificial fibre, wooden pipes, standard houses and kraft paper. The output of paper pulp alone has more than trebled itself since the revolution, and the U. S. S. R. claims to have rendered itself in this respect independent of outside sources since 1926.

Pre-Soviet forestry was mainly confined to the south. This was due partly to the poor state of development of the railways in the north and the unfavourable direction of the rivers, flowing as they do towards icebound seas. The system of minor saw-mill industries inherited from the Tzarist regime was consequently situated also in Central and South Russia and the wasteful exploitation of the forests in the immediate neighbourhood of these mills, to the neglect of those further afield, has not failed to provide Soviet foresters with an illustration of the "chaotic planlessness of Capitalist economics."

Lenin, in 1918, laid down that there must be a rational distribution of industry in the country from the point of view of proximity to raw materials, and least loss of labour in the transition from the handling of raw stuffs, through the intermediate processes of manufacture, right up to the finished product.

This task, according to a fairly recent pronouncement of Stalin, has been by no means yet successfully accomplished and a great deal still remains to be done in the matter of organisation and distribution of forest industry. An "authoritarian" State possesses enormous powers in this direction, as can be seen from the formidable list of new industrial centres established within recent years. Along the river Yenisei, for example, a new series of saw-mills is being opened, while Tobolsk has become a centre of cellulose paper manufacture as well as other wood-working factories. The Murman coast, the Chuvashkian and Karelskian republics are also becoming centres of forest industry.

A certain amount of clearing of existing forests has been inevitable in the establishment of State and Collective farms and workers' colonies,

but warned by the example of the U. S. A., the Soviet authorities claim to have avoided the pitfalls of unorganised lumbering, and every operation has been carried out according to plan.

Afforestation as a means of drought resistance plays an important rôle on the parched plains of Eastern Europe and Central Asia. In 1929-30 the amount of afforestation work in hand had risen to three times that of 1912, while in 1932 the colossal total of 3·5 million hectares of artificial regeneration were prescribed for the forthcoming Five-Year Plan, of which the majority were not regeneration works proper but new afforestation schemes for the conservation of moisture, retention of soil on slopes and in ravines, sand fixation and shelter belts. The extent of this work, says the report, "is without parallel in the history of the world." Tens of thousands of people and hundreds of millions of roubles were mobilised for the task, conceived on a new scale and with a new technique.

The second Five-Year Plan now in progress is intended to guarantee the Soviet Union its economic independence of the rest of the world, and the success of the Plan in respect of forestry is to be achieved by concentrated felling on a mechanical basis, combined with mechanisation of forest industries and means of extraction. It is to be a vastly important factor in national economy, providing for an enormous number of needs, from tools for collective farms, to a whole range of articles of daily use, which, it is claimed, can be easily produced from the bye-products of the timber industry.

To us in India who have recently been cast into gloom by the prognostications of those who would have it that timber in all its functions is being rapidly replaced by metal and other substances, this should be consoling news. Less assuring, however, is the promise that the success of the Plan will affect the "final liquidation of the detrimental bourgeois theories of forestry."

The U. S. S. R. is evidently awake to the need of specialists in forestry, and determined not to waste the material available. In addition to the Institute at Leningrad there are 20 institutions preparing thousands of technically-trained specialists of average

qualifications. In a constant stream new cadres are poured into industry, raising the technical level of the work, and making it possible to extend its range. The numbers of trained specialists in 1932 amounted to 7,900 engineers and 19,000 technicians. Yet on account of the rapid expansion of industry the demand for trained specialists is always in advance of the supply. This is a sharp contrast, as the report points out with satisfaction, to the condition prevailing in Capitalist countries, where the mass of technical intelligence cannot find scope for its powers, and in search of livelihood turns to selling papers or delivering parcels.

The Research Department has been no less thoroughly reorganised and expanded. The Timber Institute, split up in 1932 into a number of specialist scientific research institutes of forest technology; the All-Union Scientific Research Institute of Silviculture and Agricultural Melioration at Moscow and Karkov; and the ramifying system of local research organisations: such is the scientific equipment of forestry at present in the U. S. S. R., and this is closely linked with the interests of the industrialisation of the nation.

CAN YOU USE A DIVINING ROD?

BY H. G. CHAMPION, I.F.S.

In the October issue of this journal, there was mention of the standard use of the divining rod for finding underground water, but foresters in this country are perhaps not aware that in the Continental forestry periodicals there have been published a number of articles on the subject of the relation between the reactions of the rod in the hands of the experienced dowser and the growth of trees on the site examined. These articles have been fairly hotly controversial and make interesting reading whether one is already a believer or not.

The chief upholder of the rod is K. M. Müller who claims that there are narrow reaction lines all over the earth's surface which can

readily be mapped and are reasonably constant so that different workers record similar results as also will the same worker on different dates. There are two types of reaction, one due to underground water "veins" (at varying depths) and the other to cavities, faults, change of composition, etc. The reactions are considered to be due to rays of waves actually or akin to electromagnetic waves, and it is even suggested that they probably belong to the group with wave-length from a millimeter to a few centimeters. If this is correct, it should obviously be possible to devise physical instruments capable of detecting, recording and measuring them, and numerous claims to have effected this have been made. Reactions obtained on photographic plates were shown to be possibly due merely to moisture variations and at present Müller relies on a secret instrument apparently on the electroscopic principle dependent on atmospheric ionisation caused by the passage of the rays. This instrument can, however, apparently only be worked by a divining expert and is not obtainable, so that critics are not unnaturally very sceptical about it, though Müller claims practically 100 per cent. confirmation of the mapping, etc., done with the rod alone.

When now these reaction lines are mapped for any area, it is found that if a tree happens to stand on an intersection of lines (sometimes even on a single line), although all the usual growth conditions are normal or even favourable, it will very often be stunted or definitely diseased unless it happens to be an oak (or one of a small list of trees including *Acer*, *Salix* and *Robinia*) in which case it will probably be conspicuously better than average. This is the explanation of the backward tree of an avenue, and the failure of individual fruit trees in an orchard or against a wall. If you replace the dead or diseased tree with a new one giving it special attention to obtain good growth, it, too, will refuse to grow for no other reason than earth rays. In the oak forest, on the other hand, every tree will stand on a regular star of reaction lines, all the rest of the original crop having dropped out with the passage of time.

Now the critics, among whom must be mentioned Fabricius whose root competition experiments are well known in this country,

comment on the fact that it is not acceptable proof that when a diviner sees a sickly pine or a flourishing oak, he finds reaction lines all over the place leading to it. Obviously, successful prediction is required of developments on an area devoid of trees when mapped. Fabricius accordingly got an eminent dowser to map an area before it was afforested: in fact he got it done twice with a minimum of agreement between the two maps. The area was afforested with several species and at the end of the season's growth, every plant was measured and the data analysed to compare mortality and growth on the "radiated" areas indicated by each diviner, and on the small radiated area common to both maps, with the unradiated remainder. He found no significant relationships. It is of course admitted that the measurements must be repeated for another year or two to be conclusive. Careful measurements in spruce crops 47 and 83 years old similarly failed to reveal any significant differences in height, basal area or volume between the growth on radiated and unradiated portions.

Meanwhile, Müller points out that for growth to be much influenced, the tree must be exactly on the active part of the lines which has a width of only a few inches, though the rod may give a reaction even several yards on each side. This would obviously upset the deductions from Fabricius' experiment, but the general reader can hardly fail to be struck with the ingenuity shewn by the enthusiasts for the rod in dodging objections. Thus, when a middle-aged tree dies, this is because the course of the rays has changed of late.

The two types of rays mentioned are entirely different in their reactions on growth and are in fact to a large extent opposite. Oak will *only* grow normally on the water veins, whereas beech grows normally without but extra well on the other type of rays; oak requires to be on a crossing of lines to show a marked favourable reaction, whilst it suffices for a beech to be on a single line (intersections are less common with this type, resembling fault lines). Most of the important destructive fungi, *Nectria, Peziza, Trametes,* etc.,

are found on water ray crossings and are thus not truly primary, the rays being a predisposing cause.

It is not suggested that the forester can map the reaction lines in his plantation areas and plant on the lines and intersections only species known to prefer them or at least not to be harmed, using one of the other group of species between ; but stripped of all the frills, we have here an interesting subject in which there is certainly much more to be learnt and an interesting means of filling in the odd spare moment in camp. We cannot know too much about the growth of our trees and the why and the wherefore of their vigour or lack of it. Not a few among us have found the magic rod turn in our hands. I rather think I must have another shot at it myself this season and any way, it's good fun arguing about it. And let those who know all about it already set to work subjecting their skill and experience to systematic truly objective tests ; they should of course get satisfactory results wherewith to flatten the sceptics and scoffers.

Literature.

Forstl. Cb., 1934, pp. 703, 805, 808 (Fabricius, etc.)
,, ,, 1935, pp. 1, 7, 9.
,, ,, 1936, pp. 1, 309, 312.
Silva, 1935, p. 345 ; 1936, p. 185 (K. M. Müller, etc.)
Allg. F. u. J. Ztg., 1936, pp. 21, 113 (K. M. Müller, etc.)

NOTE ON METHOD OF CALCULATION OF AVERAGE CROP DIAMETER IN SAMPLE PLOT WORK

By M. A. Kakazai, Statistical Assistant Silviculturist, F. R. I., Dehra Dun.

The following note deals with a recommendation made by the 1934 Silvicultural Conference (*vide* Proceedings, p. 180, Sample Plot Field Rule 25) in connection with checking the preliminary marking

of a standard thinning grade in a sample plot, by comparing the resultant crop diameter and number of stems per acre with the yield table figures.

The data from 13 sample plots were worked up to see the effect of calculating average crop diameter by (*i*) directly taking the arithmetic mean of the diameters, and (*ii*) calculating the average basal area and then taking the diameter corresponding to this basal area as the average diameter.

The resulting figures which are tabulated below show that the arithmetic mean average diameter is always smaller than the average diameter derived through basal area, the difference being about 0.4″. Consequently the number of stems per acre corresponding according to the yield table to the arithmetic mean average diameter, for a "C" grade thinning is greater and the ratio $\frac{\text{actual number of trees standing}}{\text{yield table number of trees}}$ is smaller than the same statistics calculated from the average diameter derived through basal area. Although this ratio was actually smaller in all the 13 cases, it fell below the corresponding lower limit for the thinning grade (110 per cent., 90 per cent., 70 per cent. and 50 per cent. of the yield table number for B, C, D and E grades respectively, referring to the mean tree by basal area) in only three cases. This means that if the intensity of a thinning is checked on the basis of the arithmetic mean, it would be kept rather on the lighter side.

If a sufficient number of figures were worked out, it should be possible to arrive at factors for adjusting the percentage relationship of the number of standing trees to the yield table number of trees calculated on the basis of arithmetic mean average diameter, to correspond to the percentage calculated on the basis of the average diameter derived through basal area. It, however, seems hardly necessary to do this at present and the use of the direct arithmetic mean average diameter seems to meet requirements, especially as we know the direction in which it affects the end results.

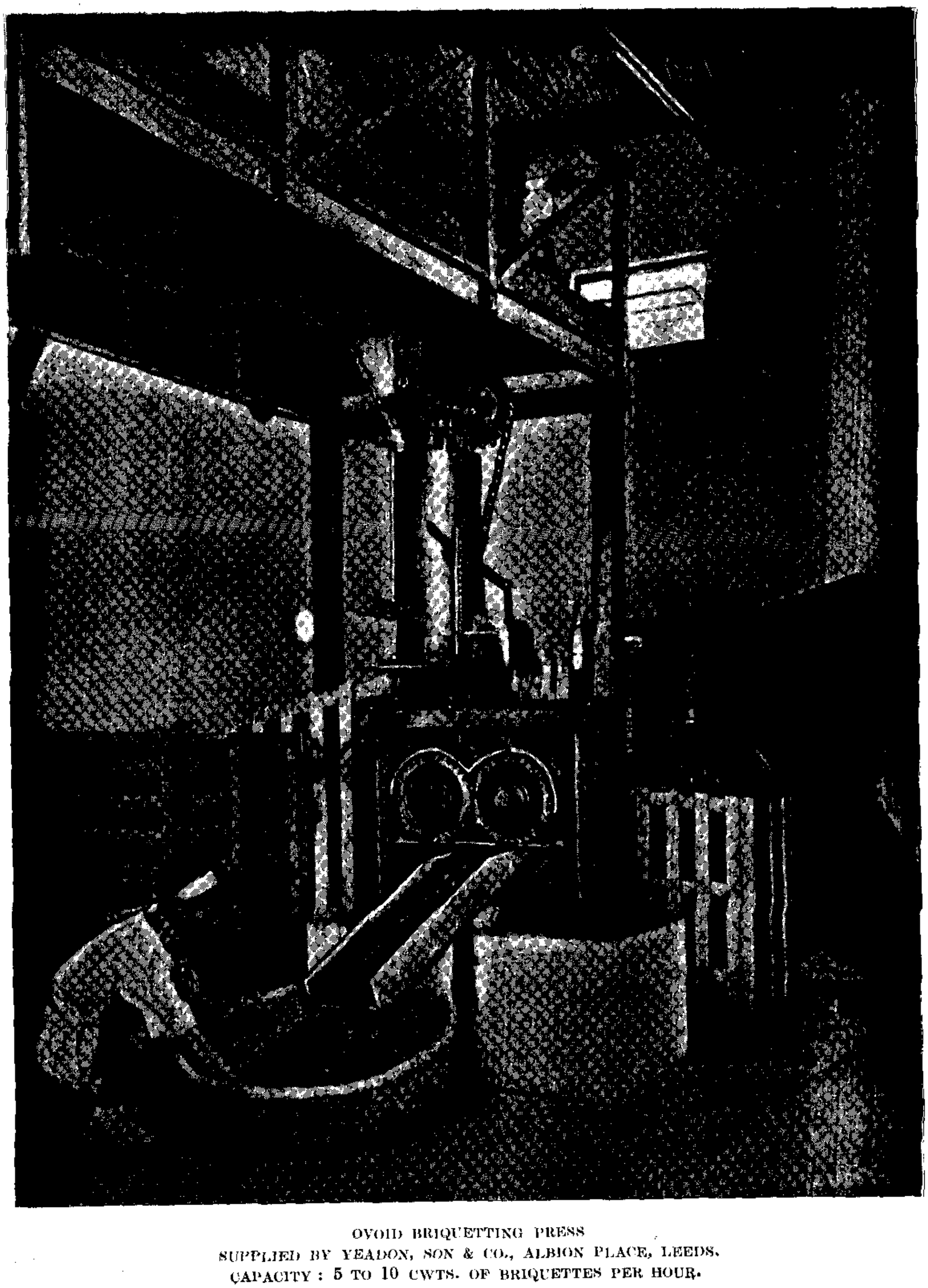
SPECIES : *Shorea robusta*

S. P. No.	Division.	Quality Class	Average Diameter		Number of Stems per Acre according to Yield Table for—		Actual number of stems on the plot per acre.	Per cent. of standing stems to number of stems according to yield table on the basis of—	
			Arith. mean.	Calculated through basal area.	Arith. mean.	Calculated through basal area.		Arith. mean D. b. h.	Mean D. b. h. calculated through basal area.
4	N. Kheri ..	0·2 I	7·8	8·1	297	282	321	108 C	114 B
11	Bahraich ..	1·3 II	10·3	10·7	199	188	168	84 D	89 D
8	Bahraich ..	0·2 II	14·9	15·5	101	93	84	83 D	90 D
36	Ramnagar ..	1·5 II	19·1	19·5	65	62	55	85 D	89 D
12	Bahraich ..	1·3 II	21·3	21·6	51	50	54	106 C	108 C
7	S. Raipur ..	1·5 II	7·8	8·0	296	286	132	45 E	46 E
1	Kurseong ..	1·4 II	10·0	10·8	208	185	133	64 E	72 D
1	Buxa ..	1·1 II	11·8	12·1	160	153	138	86 D	90 D
10	Jalpaiguri ..	3·7 I	14·3	14·7	128	122	80	63 E	66 E
2	Buxa ..	1·6 III	16·2	16·6	81	77	56	69 E	73 D
6	Jalpaiguri ..	1·9 II	18·5	18·8	70	68	51	73 D	75 D
5	Buxa ..	1·8 II	19·3	19·6	65	63	42	65 E	67 E
10	Saranda ..	1·5 I	24·2	24·8	54	54	31	57 E	57 E

BRIQUETTING OF CHARCOAL

BY S. RAMASWAMI.

Abstract.—Describes various binders such as cereals, *Bauhinia retusa* gum, tamarind seeds, etc., tried for briquetting charcoal intended for domestic use. Cereals and tamarind seeds are ground into a powder and then boiled in water to form a paste before mixing with charcoal in the grinding mill. Rice (5 per cent.) and tamarind seeds (6 per cent.) give strong briquettes, and the cost of briquetting using these binders works out to Re. -/3/11 and Re. -/2/11 respectively per maund of 80 lbs. of briquettes, and offer commercial possibilities.



OVOID BRIQUETTING PRESS
SUPPLIED BY YEADON, SON & CO., ALBION PLACE, LEEDS.
CAPACITY : 5 TO 10 CWTS. OF BRIQUETTES PER HOUR.

Charcoal is a bulky and friable product which cannot be economically transported long distances. In India, forests are mostly situated at a great distance from big towns which are the main centres of consumption of charcoal, and as charcoal does not lend itself to long transport, charcoal-making is generally limited to meet the small demand of places near the centre of production. Briquetting, which reduces the volume of charcoal by about 50 per cent. and also makes it more compact and less friable, seemed to offer a possible solution to the problem.

Moreover, when charcoal is made, a certain amount of smalls and dust are inevitable, and as there is no demand for these, they have to be thrown away as waste. (A small quantity of dust is used by horticulturists in preparing the soil for potted plants.) By briquetting, charcoal dust can be converted into a useful fuel which can be burnt like charcoal.

For these reasons a series of experiments were undertaken at the Forest Research Institute at Dehra Dun to find out (1) the best method of briquetting charcoal and (2) an efficient binder which was also economical to use. Preliminary experiments were made with the help of a small hydraulic press worked by hand, and later, further trials were carried out on a semi-commercial scale on an ovoid briquetting press driven by an electric motor.

In simple terms, briquetting consists in grinding charcoal into powder, mixing it with a suitable binder and water and then running the mix through a briquetting press. The briquettes contain a large amount of water when they come out of the press and have to be dried, a process which ordinarily takes about two to three weeks if the briquettes are spread out to dry in the air.

Charcoal is light or dense according to the species from which it is made. A light charcoal like that of chir pine (*Pinus longifolia*) or mango (*Mangifera indica*) is more porous than the heavy charcoal of sal (*Shorea robusta*) or laurel (*Terminalia tomentosa*). It has been found that compared to a heavy charcoal a light charcoal requires more binder and also more water for briquetting.

Charcoal absorbs large quantities of water vapour from the surrounding atmosphere, and as the atmospheric humidity varies widely according to the season, especially in Dehra Dun, it has been found that for the same kind of charcoal using the same kind of binder and in the same proportion, more water is required during dry weather than at other periods.

Real success in charcoal briquetting seems to rest on the use of a binder which should not only be efficient, but readily available and, above all, cheap. It should not be a product which gives off a lot of smoke or retards the burning properties of the briquette. Thus, tar and pitch are good binding products, but they give off a lot of acrid smoke when burning and are, therefore, not suitable binders to use if the briquettes are to be used for domestic purposes. Numerous binders have been tried at Dehra Dun including *Bauhinia retusa* gum, dextrin, rice, barley and other cereals, ground tamarind seeds, chopped and ground prickly pear plants, and molasses.

Bauhinia retusa gum gives a good strong briquette, when used in the proportion of 6 per cent. Very strong briquettes are obtained when 5 per cent. of this gum is used together with 1 per cent. of rice. The trouble with *Bauhinia retusa* gum as a binder is that it is very difficult to grind into a powder unless it is quite dry, and during rainy weather it absorbs so much moisture that it has to be artificially dried before it can be ground. Various methods of using this gum have been tried, such as powdering and adding it to the charcoal when the latter is being ground in the mill, mixing the powdered gum with water and adding this thin paste to the charcoal, and grinding the charcoal with water and then adding the powdered gum. The most economical method is to grind the lumps of gum first in the grinder and then to add to it a suitable quantity of charcoal. Water is added last of all.

The starchy binders were ground to a fine powder and then made into a paste by boiling in water, and the paste was added to the charcoal while it was being ground in the mill. Of all the starchy binders tried, 5 per cent. rice gave the best results. The cheapest quality broken rice was used.

The testa or seed coat of tamarind seeds contains a sticky substance with binding properties, but as the testa could not be easily separated from the kernel, the whole seeds were ground and boiled in water to form a paste. This binder (6 per cent.) gave very good results. In various parts of South India tamarind seed is a waste product of little or no value and in such places it might be the cheapest binder to use.

As already mentioned above, the quantity of water required for briquetting with the binders described in the previous paragraphs varies according to the nature of the charcoal (light or dense) and the season. Speaking generally, we can say that about 60 to 70 parts by weight of water is required for 100 parts of charcoal.

The grinding of the charcoal has a great influence on the strength of the briquette. Not only is the charcoal converted into a powder in the grinder but it is also thoroughly mixed in it with the binder and water. Hence, the more the grinding, the stronger the briquette. But, as grinding costs money, there is an economical limit beyond which one cannot go. In all the experiments at Dehra Dun it was found that grinding for ten minutes was quite sufficient for all practical purposes and this period was later strictly adhered to in all cases so that different binders could be compared. The grinder used in the experiments was an old *soorki* mill. A *soorki* mill is all right for experimental purposes, where the time spent in loading and unloading by hand is immaterial. But, on a large commercial scale some form of grinder with an automatic feed would be required, if cost is to be kept low.

When charcoal is ground, a lot of fine dust is produced which forms an explosive mixture with air. Any danger from this source can be avoided by adding water or the paste to the charcoal immediately after it is placed in the mill.

When prickly pear (*Opuntia* sp.) plants are chopped and ground in the mill, a sticky mass is formed, but this product makes but a rather weak binder. No water is required in this case, as there is plenty of water in the plants, but as the amount of water in the plants

varies very widely according to the season, the quantity of binder to be used has also to be varied according to circumstances.

The following table gives a summary of the results of the charcoal briquetting experiments with various binders.

CHARCOAL BRIQUETTING

Sl. No.	Binders Used: Name	Binders Used: Percentage	Nature of Briquettes: Strength	Nature of Briquettes: Burning qualities	Cost of briquetting per maund of 80 lbs. of briquettes.	Remarks
					Rs. a. p.	
1	Rice ..	5 per cent.	Strong	Good	0 3 11	
2	*Bauhinia retusa* gum	6 ,,	,,	,,	0 7 0	
3	Rice .. *Bauhinia retusa* gum	4 } 5 } ,,	,,	,,	0 8 2	These briquettes are stronger than those made with rice alone or gum alone as binders.
4	*Tamarind* seeds ..	6 ,,	,,	,,	0 2 11	
5	*Opuntia* sp. chopped and ground	100 to 125 per cent.	Weak	Very good	..	No water used.
6	Molasses ..	70 to 80 per cent.	Very strong	*Good but* smoky	..	,, ,,

NOTES.

1. Cost of briquetting includes interest on capital at 6 per cent., depreciation on machinery at 20 per cent., power charges and labour, but does not include the cost of charcoal.

2. *Burning tests*: Charcoal briquettes being highly compressed and with a smooth surface do not catch fire quite so easily as ordinary charcoal nor do they burn as vigorously as charcoal. But briquettes burn more steadily and last twice as long as charcoal for one filling of a stove. Nos. 1, 2, 3, 4 and 5 in the above table give off no smoke when burning, except a very small quantity when the fire is lighted.

3. The briquettes prepared with the various binders shown in the table were not affected by storage of over two years, the only exception being the molasses briquettes, which absorbed a large amount of moisture from the atmosphere during the rainy season. Baking the molasses briquettes at a low heat in an oven solves this problem, but adds to the cost.

Conclusions.—From the viewpoint of the consumer charcoal dust *briquettes do not appear to offer any outstanding advantages over* ordinary charcoal and so he cannot be expected to pay for such briquettes a price higher than he pays for charcoal. This means that the cost of briquetting charcoal dust must be kept as low as possible, and in this connection the use of rice and tamarind seeds as binders offers commercial possibilities.

Briquetting of good charcoal which can be sold as such is not a commercial proposition. A good method to adopt is to pass the charcoal as it is taken out of a kiln on a coarse sieve with 1 inch holes and to use for briquetting only the dust and small pieces which fall through. The big pieces which remain on the sieve should be bagged and sold as charcoal.

REVIEWS

THE IMPROVEMENT OF NATIVE AGRICULTURE IN RELATION TO POPULATION AND PUBLIC HEALTH

SIR DANIEL HALL.

This series of Heath Clark Lectures delivered at the London School of Hygiene and Tropical Medicine in 1935, though dealing with African conditions, should be read by all interested in the welfare of the Indian agriculturist, or, indeed, in the welfare of the Indian nation as a whole. The parallelism of African and Indian conditions is so close that one may read page after page and apply the lessons taught to India.

The first lecture is concerned with the maintenance of the fertility of the soil, a concise statement of the relation of soil fertility to the mineral and bacterial content, rotation of crops and manures.

The next lecture is one of absorbing interest to India—the reform of shifting cultivation. This method of cultivation has been almost entirely stopped in the Bombay Presidency, but persistent demands for its continuance, especially in Kanara, point to the necessity of a careful reading of this chapter by those who might be tempted to toy with the reintroduction of this pernicious system. This system, known as *kumri* in Kanara and *khandar* in the Dangs, is that of felling a timbered area, burning the resultant debris, and the raising of field crops for one or two years. After that, the cultivator moves on and clears another patch of jungle, as the fertility of the soil is exhausted and weeds have become excessive. The original clearing is left to grow up again for a period of, say, five to seven years. " In this way the primeval forest is destroyed. Another point is the fact that the ever increasing search for new land results in the denudation of the virgin forest, which is replaced by a secondary growth of inferior quality, and here and there completely ousted by the pernicious weed *Imperata*." In Bombay we must substitute *Lantana* for *Imperata*. Hall suggests methods of replacing this system of shifting cultivation by a fixed method of farming, which will produce the same

amount of food from a smaller area of land continuously cropped. But in Bombay the land usually taken for *kumri* is not agricultural land, but hill sides where there is heavy rainfall—the surface soil is denuded after the inferior crops are harvested, and a long period of recuperation under forest conditions is required to produce a soil and to bring back its fertility. Very often the soil is eroded to the rock, and we have the bare infertile slopes so often seen in the Presidency, rainfall is not held up, flooding in heavy rainfall occurs and the streams dry up immediately afterwards. But it is in the next chapter that one finds most food for thought—overstocking and soil erosion. The clearing of the forests from the hill slopes in areas of heavy rainfall, or even of moderate rainfall, such as we have in the Deccan, is bad enough; but a period of rest would bring back the scrub and the forest growth were it not that other adverse factors effectively prevent that desirable result.

One is tempted to quote much of this lecture, as it is here that one finds so many features that are those of India too. For instance :

> "The Bantu, who are the chief agricultural race in Africa are at the same time breeders of live-stock—cattle, sheep, and goats. In the main they do not use these stocks for food purposes; they drink milk to a limited extent, but eat meat only on ceremonial occasions; the hides and skins are dressed for sale and for clothing. Since the British occupation has put an end to warfare and raiding, these live-stock have multiplied enormously in numbers, and constitute the chief source of demand for more land, *far more than the requirement for increased cultivation.* Almost everywhere there is serious overstocking, to the point of endangering the land itself." "The difficulty of the situation lies in the fact that among the Bantu, cattle enter into tribal custom and religion." "The owners are indifferent to the quality of the stock; numbers alone count."

The two last sentences are applicable to India. In Kenya a population of three million own about six million cattle, "but the majority of that population has little or no milk for the use of them-

selves or their children during the dry months of the year." "In many parts where there used to be grass, there is nothing but bare earth, and although we do not agree with some witnesses that there has been a decline in the annual rainfall, there is no doubt that, owing to the denudation of the soil, such rain as falls, quickly runs off the hard pan which has formed, or evaporates, and is of far less benefit to the land than when the soil was covered with grass."

In the Kenya Land Commission Report we find the following :

"A journey through the area reveals that over large stretches of hillsides vegetation has been almost wholly removed. The soil has been eroded down to the sub-soil and its removal will continue at an ever-increasing rate. On less steep slopes and on better land, vegetation still persists. But even there the grazing has been so persistent that the ground is all beaten down into little stock paths, and has in its turn become open to erosion."

How true also of the Deccan hills !

"It is not too much to say that a desert has been created where grazing was formerly good, and where even cultivation existed, and that the desert conditions are steadily approaching the land carrying stock and cultivation."

"The Wakamba solution of the difficulties is that they should be given more land. But there is no considerable area now open, and even if new land could be found the process of destruction would only be renewed. No space would be big enough so long as they only aim at increasing the number of their stock without utilising them."

"The greatest danger, however, lies in the fact that over-grazing may so destroy the vegetation and bare the surface that soil erosion sets in. In all tropical countries, even where the rainfall is low, torrential rains occur." "Of all live-stock the goats are the worst offenders ; they graze more closely, on bushes as well as grass, thereby never allowing forest growth to regenerate by seedlings, and their sharp feet break the surface. Within historic times they have been the chief agent in the deforestation of the lands bordering on the eastern Mediterranean, whereby

the hillsides have been bared down to the rock, and the lower reaches of the rivers choked with silt and converted into swamps."

(One is reminded of the old, silted harbours of Ratnagiri, Kolaba and Thana.)

In South Africa "the same causes are at work, and they will inevitably produce the same effect in the near future—denudation, donga-erosion, deleterious plant succession, destruction of woods, drying up of springs, robbing the soil of its reproductive properties, in short, the creation of desert conditions."

In Kenya "the people show absolutely no regard for the ruination which is going on before their eyes, but devote their lives to amassing vast herds of uneconomic stock which are fast turning the country into a desert."

"The problem of overstocking involves the preservation of the means of existence of many African tribes because it destroys the soil itself."

"The vicious circle is closing in at an accelerated rate. . . ." "In places famine is at hand . . . the head of live-stock, especially goats, has to be reduced drastically to numbers the natives can keep and utilise as food, regenerative measures have to be set on foot to reclaim the eroded land, first into grazing, eventually into arable land."

Elsewhere Sir D. Hall says: "The brunt of the campaign against overstocking should fall on the goats, which are less than ever valuable to the natives because they are everywhere tending to abandon skins for clothing."

In this Presidency all these extracts have a very present import. Large herds of useless cattle are kept by the villagers, which not only consume the fodder which might go to selected stock to their great improvement, but the over-grazing of the waste and forest lands is too apparent, with the concomitant evils of erosion, silting, and deterioration of the grazing lands in no less a degree than Sir D. Hall brings to our notice. Most of the Deccan uplands and hills are much over-grazed, and many of the forest areas too. There is a deteriora-tion of the quality of the grazing. Good grasses are eaten off before

they have time to shed their seed, coarse and tufted grasses, usually of a perennial kind, displace the usual soft nutritious grasses. The soil on the hills has come down to the rock and pan so that whatever grasses occur they are small, innutritious, and repugnant to cattle owing to the development of spears.

Enormous herds of sheep and goats, usually belonging to landless professional graziers, roam over these lands, effectively preventing the growth of any shrub or forest growth so that the soil can never stay against the monsoon downpours.

The solution to these evils would appear to be an endeavour to discourage the keeping of useless cattle, the rigid exclusion of goats from hillsides, the regulation of grazing to prevent the over-grazing of any one area and to favour the seeding of the more useful grasses by a well-thought-out system of seasonal reservation of seed areas.

The denudation of many of these hills has gone far, and little can be done to hasten their return to fruitfulness ; yet if such measures were taken, their gradual amelioration could be effected. In many places subsidiary help can be given by the making of contour-line low walls to catch the eroded soil, but this can be done only on gentle slopes ; on steep slopes the only means is rigorously to exclude goats, to allow the scrub and forest to grow up again to hold the soil and to mitigate the rapid off flow of the monsoon rain.

There is urgent need to organise all the waste lands and to impose restrictions such as will bring them to a condition affording ample grazing of good quality for the cattle of the better sort. Those of inferior breed and quality should be excluded by the imposition of such a grazing fee that it would not be possible for the villager to keep them. Unless the grazing is improved there is not much hope of improving permanently the breed of cattle however much attention is paid to the careful selection of bulls and cows.

In this Presidency the low forest grazing fee, two to four annas per head, is an incentive to preserve thousands of inferior cattle which the villager could well do without,

The final Chapters, The Native Dietary and Administration, have much of interest, and both are closely concerned with the agricultural problems of Africa ; and they are of interest to those too who have the welfare of India at heart.

R. W. INDER.

AUSTRALIAN FORESTRY

We have received with much pleasure the first number of our contemporary *Australian Forestry*, the organ of the "Institute of Foresters of Australia." The objects of the Institute are—

(1) To promote and encourage the study of the science and practice of forestry in all its branches.

(2) To create and maintain a high standard of qualifications in persons engaged in the practice of Forestry.

(3) To promote honourable practice and to decide all questions of professional usage and etiquette.

(4) To collect and circulate statistics and other information relating to forestry in all its branches.

The President of the Council is Mr. S. L. Kessell, the well-known Conservator of Forests of Western Australia. The first number of the journal contains interesting articles on plant nutrients and pine growth which describe various apparently deficiency diseases of introduced pines in Western Australia. Messrs. Kessell and Stoate, the authors, show clearly the necessity of mycorrhiza in nursery practice and how the inoculation of new nursery sites with *rhizopogon luteolus* removed all the difficulties of stunted and abnormal growth previously experienced. In the plantations suffering from want of vigour remarkable results were obtained with superphosphate. The journal also contains interesting articles on forest fire weather, Eucalypt planting in South Africa, the root development of *Pinus pinaster* and other articles. Altogether an admirable journal of which the new Institute of Foresters of Australia may well be proud. May we suggest the inclusion of illustrations as funds permit as these greatly add to the interest of any journal.

C. G. T.

BIG GAME ENCOUNTER

BY STANLEY JEPSON (WITHERBY).

(Available through the Times of India Press, Bombay, Price Rs. 5-8.)

This is a good book, very well printed and published at a most reasonable figure.

There is a foreword by the well-known shikari and author, Col. Glasfurd, in which the book is highly and justly praised, but in which it is regretted that pigsticking adventures have not been included.

Section I comprises 26 chapters that give the exciting experiences of various shikaries and others in the pursuit of big game. These experiences are chiefly confined to India and include those of a number of Forest officers. They have been chosen from among a series of articles that appeared not long ago in the *Illustrated Weekly of India.* All are interesting, and quite a number emphasise that exciting and dangerous experiences with big game are often due to carelessness or ignorance on the part of the hunter. Indeed, one famous shikari, Col. A. E. Stewart, excused himself from contributing on the grounds that, in his opinion, all tense moments in big game hunting are a confession of error, and generally of error that the sportsman ought to have avoided. This is rather an original viewpoint and most people believe that tense and dangerous moments are unavoidable sooner or later in the pursuit of big game. Indeed, if it were possible to avoid danger altogether in big game hunting, it would lose much of its appeal ; and in any case it is of great help to the novice to learn from the mistakes of others.

Section II, written by the Editor, is, if possible, more interesting than Section I. It consists of three chapters that discuss the mind of the wild, how wild animals attack, and the fear complex in the wild. These chapters are very ably written and should be read by all who are interested in wild animals. Discussing animal psychology and the sixth sense, Mr. Jepson advances the theory that what wild animals really fear is not the evil or good thought waves that may or may not emanate from the hunter, but the *attention of humanity* in any form. This theory appears to the reviewer to be probably very near to the mark,

The book closes with an able appeal for the preservation of wild life. As the author says, were the Taj Mahal to be allowed to fall into ruins or be destroyed, a cry of indignation would arise throughout the world. But the Taj Mahal was built by man and could probably be re-created by him. Yet many rare animals, equally beautiful, are on the verge of extinction and no man can re-create them. No howl of indignation arises and the total loss of beautiful species after species of animals and birds is treated with complete apathy. Some countries are doing more than others to preserve for all time their indigenous fauna and flora, but India has certainly not taken the lead in this matter. True it is that during the last few years a small band of enthusiasts has arisen in this country and is doing noble work in trying to awake public opinion to the need of helping the fast diminishing animal population of this great Empire, but there is still a great deal more to be done. May Mr. Jepson's appeal help on this good work !

F. W. C.

CANADIAN WOODS

THEIR PROPERTIES AND USES

BY T. A. MCELHANNEY AND OTHERS.

At the request of the Canadian Lumbermen's Association, this book has been prepared by the staff of the Canadian Forest Products Laboratories. It contains altogether ten chapters, dealing with different aspects of timber utilization, namely, structure of wood, mechanical and physical properties of wood, seasoning of lumber, decay and stain in wood, preservative treatment of wood, paper pulp and related products, chemical utilization of wood and classified uses of Canadian woods. The existing data on each subject have been summarized and written in clear and simple language. At the end of each chapter a short bibliography has also been added. Finally, it may be said that the book is a comprehensive treatise on Canadian woods and will be of great help to all who are interested in the wood-using industries of Canada.

K. A. C.

EXTRACTS

THE CAUSES OF FLOODS IN THE PUNJAB

A lecture on "The Causes of Floods in the Punjab" was given on Tuesday evening by Dr. R. Maclagan Gorrie, of the Indian Forest Service, under the auspices of the Lahore branch of the Young Men's Christian Association. The chairman was Mr. F. L. Brayne, Rural Reconstruction Commissioner, and the lecture was illustrated by a very fine series of lantern slides prepared from the lecturer's own photographs.

Most human activities in the drier half of India (said the speaker) are limited in some way or other by lack of water. Enormous sums of money have already been spent upon irrigation and hydro-electric projects, and now that public health problems are being tackled in the larger municipalities, an increasing sum must inevitably be sunk on city water supplies. Where is this water to come from? From rivers and underground water resources. But how did it get into the rivers and underground? From rain and snow. How much of the total rainfall is lost in sudden floods, and how much finds its way underground to feed the springs and wells? All over the world people are apt to think that floods are inevitable and cannot be controlled or prevented. In the case of our great Himalayan rivers, floods cannot be prevented entirely but I hope to show you to-night that they could be controlled to a quite appreciable extent.

To understand how floods arise, I should like you to think of one or other of the great Punjab rivers. Our rivers fall into two groups. In the first are the Sutlej, the Chenab, the Jhelum and the Indus, all of which rise in the great glaciers beyond the main Himalayan range. In the second are the Beas, the Ravi and the other smaller rivers which rise on the southern or nearer slopes of the main range.

RIVER CATCHMENTS

The "catchment" of a river is the total area of country from which its drainage is derived. Those rivers which have a large catchment area in the high country above 10,000 feet altitude with plenty of glaciers and eternal snow, start their seasonal rise early in the summer through the melting of snow. By the middle of June they are carrying a quantity of water probably 20 to 100 times greater than during their lowest winter level. This rise due to the melting snow and glacier ice is a steady and cumulative one and is not by itself the cause of sudden or unusual floods. But the snow melting continues through the summer and the monsoon season when it combines with monsoon rain. The heaviest monsoon rains fall upon the lower outer slopes of the Himalayas, the highest intensity of rainfall being between 4,000 and 9,000 feet elevation. Parts of the Kangra foothills receive as much as 80 inches of rain during July and August, but further west in the Punjab the monsoon is much more erratic and there may only be a few inches falling in two or three sudden storms.

For the larger rivers, the area of foothill country is quite small compared with the total area of their catchment, but the effect of these monsoon storms in the foothills is out of all proportion in causing floods in the plains below. To understand why this is so, I should like you to puzzle out what happens to rain. How much of it is absorbed by the soil and how quickly does the rest find its way into the nearest river?

When rain falls on a land surface, some of it is absorbed in the soil, and some drains off the surface. The amount that is absorbed depends on many things, but it is obviously least on bare rock, from which it pours off just the same as from off a house roof, leaving the surface dry a very short time after the rain stops.

DIFFERENT SURFACES

If the surface is flat the water takes longer to drain off than from steep slopes, whereas on the steep stony slopes the whole pours off as surface drainage. When the surface is bare soil, as in fields, the amount of rain that sinks in is much greater on a ploughed surface than on a hard-baked flat one, such as is commonly found in fallow fields and on grazing grounds packed hard by the feet of domestic livestock. When the surface is of grass or forest, with a thick plant cover growing as nature intended, the share of rainfall which sinks into the ground is very much greater, and much of this eventually finds its way down to the deeper underground reservoirs which supply perennial springs and wells. But when seriously depleted by grazing, fires, or other interference by man and his domestic animals, the plant cover is no longer so good a sponge and the run-off increases in pace and suddenness.

A thick cover of vegetation serves as a sponge to absorb a large part of the rain which falls upon it, and it also keeps open the pore spaces of the soil. In bare ground, these pore spaces become sealed up and the surface rendered impervious, because they get clogged up with tiny particles washed across the eroded surface. Although the plants themselves return a good deal of moisture back to the air by transpiration, the good they do in protecting the soil and keeping it porous, far outweighs the amount they require for their own life processes.

It is for these reasons that public bodies all over the world are paying such close attention to the protection of plant cover in catchment areas which supply urban water. In the Punjab and the United Provinces, water has already got a definite commercial value, though not so high as in California, where some of the cities have already spent fabulous sums upon securing and protecting their water supplies, which may have to be brought 200 to 300 miles from the catchment area to the city. The land of the catchment area may be forest or hill pasture or a wilderness of rock and snow with no intrinsic value of its own, but when assessed in terms of the water it produces and the large investments in property, canal developments, reservoirs, machinery, and human welfare all dependent on the water supply which it produces, the value of such a catchment area must be very large indeed.

For instance, 150 square miles of the Uhl river valley produces the Punjab hydro-electric power, for which already some 7 crores of rupees have been spent on power development and distribution. In terms of investments sunk, therefore, the land which produces this water carries a value of Rs. 700 per acre, although from the hill zamindar's point of view it is only fit for grazing a few head of sheep and goats and brings in practically no revenue to Government other than its value as a catchment area.

One might expect that the source of such wealth would be given some attention, but in actual practice most water engineering projects take for granted the continued

supply of their basic material, water, without paying very close attention to the conditions controlling it. Nor has any allowance been made for the deterioration in its efficiency as a water-catching machine brought about by the misuse of the land through bad agricultural practices.

CANAL SUPPLIES

It is equally important for the prosperity of both town and country dwellers to look after the catchment areas of our canal supplies. The possibility of husbanding these supplies by the control of grazing and improved field cultivation should be explored for the parts of the catchments which are under our political control. In the case of the Sutlej, Jhelum and Indus, much of their catchments are beyond the borders of British India, but as I have tried to show you, the zone of worst flood danger is the foothills inside the Punjab province and neighbouring Indian States.

The usual way to measure the amount of water available for human use is by the gauging of streams, *i.e.*, by keeping a record of the quantity of water flowing. This gives some useful indications of the amount of water draining from any given valley, and if sufficient rainfall measurements are also made, one can calculate what total mass of rain has fallen, and how much out of this has found its way down the river. The highest floods are of course of very little use for power or public water supplies, in fact the more sudden the rise and fall of a flooded river, the more water is wasted in the peak of the flood which cannot be made use of in the same way as a perennial flow can be.

In addition to gauging the streams, however, much valuable information can be obtained about the fate of rainfall by means of small plots and tanks of local soil with different samples of the plants growing there. The movement of rain water on the surface and the amount absorbed and passed down to the lower levels can be studied. The amount which runs off the surface and the amount seeping into the soil can be measured accurately for quite small tanks with only a few square feet of surface, and the results can be applied to larger areas to show just what type of plant cover gives the best results in terms of a constantly flowing river of clear and naturally filtered water.

AMERICAN COMPARISON

Recent American figures collected in this way show that for soils very similar to our Punjab foothills, grass covered ground allows only one twentieth to one thousandth part of the amount which escapes as flood water from ground which is bare but otherwise identical. Other figures for foothill catchments somewhat similar to the Rawalpindi hills show that plants with bushy fibrous roots are more efficient rain trappers than are plants with a few large coarse tap-roots. Each fibrous-rooted plant (for instance a bunch of fodder grass) conveys two or three times as much rain water to the underground as does a tap-rooted plant (such as the common weeds). Now the fibrous rooted species include most of the plants which are preferred by grazing cattle and sheep, so that good grazing grounds are at the same time good water catchments, and land can be managed for these two important objects together,

At present, unfortunately, the hill grazier prefers to keep a mob of half-starved animals which yield a few *chitaks* of milk a day and are so weak that they can hardly pull a plough. If he reduced his herds to a reasonable number, the individual animals would give him more milk and better service, but until a drastic reduction of herds is brought about there is no prospect of improving the hill grazing grounds and they will continue to deteriorate. As long as this deterioration is allowed to go on unchecked, the hill grazier is the worst enemy of the Punjab, because flood damage in the populous plains will increase and the winter water supply for the canal colonies' *rabi* crops will get worse and worse. If democracy in the Punjab is really to bring about the greatest good for the greatest number the ignorant short-sightedness of the hill dwellers should not be allowed to stand in the way of an improved water regime for the province as a whole. All of you who have the welfare of this great province at heart should do what you can by propaganda and education to make known the real causes of disastrous floods.

PROFESSIONAL HONESTY AS REGARDS SELECTIVE LOGGING

BY RALPH C. HAWLEY, YALE UNIVERSITY.

During the last few years a great deal of attention has been given both in forestry and industrial circles to the subject of selective or partial cutting of forest stands. It is hardly necessary to define for the readers of this JOURNAL what is meant by the term "selective logging" or "partial cutting," since this side of the matter already has been covered by other writers.

The late W. W. Ashe was among the first to place emphasis on the fact that often there is no profit, but instead a loss, in cutting small trees even though of size to give merchantable products. He pioneered in the field and did much to bring out the importance of this subject. The idea in itself could scarcely be called new to professional foresters, since the whole theory of raising forest crops presupposes growing them for utilization at the most profitable sizes. It might then be considered unnecessary to stress the fact that trees should not be cut until they have attained that desirable, profitable size.

However, foresters quickly recognized the value of Ashe's presentation of the idea as an aid in introducing private landowners to the whole subject of forestry. It was an entering wedge, with great advertising and selling value for influencing private landowners to give consideration to forest crop production, or at least to stop their current methods of devastating the forests which they operated. Hence it is not surprising that there has been a movement all over the country aimed at showing the boundary line between trees of profitable versus unprofitable size for cutting, and explaining the financial advantages which may accrue when unprofitable trees are left in the woods.

The development of this idea and the bringing of it into practice in the forest justifies further advertisement. However, in the effort to take advantage of partial cutting and selective logging as a bait for leading private owners into the practice of forestry, professional foresters have in some instances attempted to extend this style of cutting to situations outside its legitimate range. It has in some cases

amounted almost to a deification of partial as contrasted to complete cutting of the stand. From the biological standpoint it may be true in many, though certainly not in all cases, that partial cutting is superior to clear cutting; yet from the practical standpoint of securing a specific crop, there will be instances where a clear cutting method better suits the requirement of the forest manager.

Selective logging is not suited to all forest species, nor to all situations (natural and economic). From the *ecological standpoint, there are so many factors* to be considered as to make it obvious that any one system of cutting cannot be made to fit all conditions.

The essential idea of selective logging, namely, that only profitable trees (usually trees of the larger size or better quality classes) will be cut, works out in the field, when skilfully applied over a considerable period of time such as a forest rotation, in one of three ways:—

(*a*) As the result of the selective logging or partial cutting, trees of several age classes intermingled are established and maintained on the same area. This is unevenaged arrangement and permits of successive cuttings over the whole area at intervals.

(*b*) The profitable trees occur and are removed *in solid blocks or groups, and* these may be interspersed by blocks of less profitable trees (younger or of inferior species or quality) which are left uncut. Here is seen a forest containing evenaged stands of a variety of age classes. The idea of cutting only profitable trees is followed out because only the old age class with the biggest and best timber is harvested.

(*c*) The selective logging or partial cutting becomes a continuous tending of single trees over the whole area. This resolves itself into a light cutting in each stand at intervals only a few years apart, removing each time a few of the biggest or most profitable trees. Such a method of cutting may tend either toward the maintenance of a fairly regular two-storied arrangement of the trees in the stand, or may tend toward a many-aged arrangement. In either case partial cuttings of this type are extremely intensive and have as a counterpart the European technique known as "Dauerwaldwirtschaft," "Einzelstammwirtschaft," etc.

Undoubtedly some of the writing on the subject of selective logging in this country has obtained its inspiration from consideration of these very intensive European types of cuttings. They represent high utilization of site from the production standpoint, but require conditions permitting intensive management for realization of the high production potentially incident to the method. Forest conditions in this country have not as yet reached the stage where application of such intensive management is generally practicable or, in many cases, silviculturally best.

Some of the advocates of selective logging and partial cutting, carried away by the theoretical idealism of the concept, *have overlooked the fact that* such methods work best in pure stands under biological conditions which prevent a change from one forest type to another almost irrespective of the style of cutting. The ponderosa pine type may be taken as an illustration of this point. Because of the inability of other species to grow under the site conditions characteristic of the ponderosa pine

type, there is no danger of these areas being seized by other tree species as a result of cutting. If a forest cover is maintained at all, it will be ponderosa pine, and hence whether the cutting is clear cutting or the lightest type of partial cutting means little from the standpoint of change of type. On the other hand, stands of northern white pine in the north-eastern United States, if managed on a system of selective logging over a single rotation, are likely to be replaced by other species of greater tolerance and of more mesophytic habit.

There are undoubtedly many forest types in the country where selective logging or partial cuttings of the character listed under headings *a* and *c* will fail to maintain a forest crop similar to the one harvested. In some cases such a consequence may be just what is wanted, but in many cases a crop of the same tree as is harvested may be desired. Where maintenance of the climax forest is the aim in forest management, selective logging is more likely to react favourably than where a temporary type is the preferred forest crop.

Consider the Douglas fir forest in the Pacific North-West. These stands may be pure, or may contain considerable mixtures of such associates as western hemlock, Sitka spruce, lowland fir, and Arborvitae,—all more tolerant than the Douglas fir. Even where the Douglas fir is practically pure, an understory of these species is likely to develop as time passes. Emphasis today is being placed on the possibility of going into these stands, which range from 150 to 800 years of age, with more flexible types of equipment than have been used in the past, enabling selection of certain trees and the leaving of the balance of the stand instead of the customary extensive clear cuttings.

Selective logging in these stands of course removes the most profitable trees, which means the best Douglas fir and more valuable timbers such as Sitka spruce and Arborvitae, leaving defective individuals of all species and sound trees of the less valuable hemlock and lowland fir, together with small trees of all species.

This is a radical change as contrasted to the old method of operating and character of cut, and is likely to be significant in its results. To the operator it brings a better financial return and may enable him later to introduce conservative practices in the woods, to carry his present investment and eventually turn his operation over into one of sustained yield management. However, from the standpoint of the succeeding crop of timber which is likely to follow, the results may be unfavourable. Possibly the defective individuals and the trees of the least valuable species may extend their crowns over a large share of the area, and hold the ground against the better species. The abundant supplies of seed produced by the inferior species and the ability of these species to reproduce under the conditions of light cutting may result in a much smaller representation of good species in the new crop than existed in the stand before initiation of selective logging. Consequently the result of the partial cutting in this case may be future crops of poorer quality. This calls attention to the fact that the practice of good silviculture, particularly in mixed stands, demands the cutting of many unprofitable trees. Selective logging and partial cuttings of profitable trees will only accidentally and in occasional cases prove successful in establishing good crops of timber.

The purpose of this article is not to discredit or to discourage the use of partial cutting and selective logging where applicable, but rather to protest against accepting these as universally approved methods of harvesting timber.

Let us as professional foresters work with our eyes open, not blinded by any one theoretical concept which may be good so far as it goes but which common sense tells us cannot be equally good everywhere and may not cover the whole subject. Let us on the other hand envision the future results of any partial cutting which we contemplate, and weigh the advantages and disadvantages, not only on the basis of the immediate financial profit of the operation, but also upon its ultimate consequences. Use the propaganda value of selective logging for all it is worth, but be honest with yourself and do not be led into thinking that partial cutting or selective logging is a panacea which will solve all the problems of silviculture.

(*Journal of Forestry*, February 1936.)

PLANT HUNTING AND EXPLORATION IN TIBET

The second evening discourse at the Blackpool meeting of the British Association was delivered on September 15 by Capt. F. Kingdon-Ward. He said that however much we may regret some of the results of the industrialization of Britain—the destruction of forests, the urbanization of pasture land, slums and so on—our country is in some respects, a vast improvement on the England of the four centuries ago. It was then a colourless land, especially during the winter. Thanks to the great interest taken in horticulture and silviculture to-day, it is that no longer. About 12,000 species of introduced trees, shrubs and herbs are cultivated in the open—nearly ten times the total number of flowering plants which occur wild. Thus the British climate must be singularly elastic and the plants themselves highly adaptable. Probably in no other country in the world of equal area can so many alien plants be grown. Some are difficult, but more are easy, and not a few naturalize themselves.

Tibet, the highest plateau in the world, is not, as is generally supposed, a complete desert. There is a gradual increase in the flora from west to east, and from north to south, corresponding with the change in the physiological nature of the country; the vegetation slowly changes from tundra to scrub and grassland, and from scrub to forest. Naturally, the most prolific and varied flora is found in the forested south-eastern region. This flora is a mixed one. The climate varies greatly from warm temperate at the bottom of the gorges where Tibet reaches its lowest altitude at 5,000 feet, to sub-arctic on the high snow-clad ranges, the peaks of which attain 25,000 ft. All adjacent regions—China, Indo-Malaya, the Himalaya—have contributed to the flora of Tibet. Not every plant found there is hardy in Britain, but a surprising number are. Nor is it possible to forecast whether a given plant will be hardy or not; experience enables one to make a shrewd guess, but no more. On the whole the plants which have proved most adaptable to our gardens are those which are not found growing under extreme conditions; that is to say, the plants, not of the tundra, nor of the deep forested river gorges, nor of the highest alpine ranges, but those of the intermediate scrub-clad plateau country, at 10,000—12,000 feet altitude.

Throughout the summer one is busy collecting plants in flower. In late autumn, one starts harvesting seeds. It is not necessary to mark the plants when in flower, of which seed is required. Most plants are found over extensive areas where the climate conditions are similar, and constant practice enables one to recognise a given plant by its fruits as readily as by its flowers. Particular plants occur in prodigious numbers; most species are at least common; the difficulty is to discover a rare plant! Capt. Kingdon-Ward said that he could recall very few of which he discovered but one specimen—*Leycesteria crocothyrsos* is one of them.

Tibet has become famous as the land of the blue poppy (*Meconopsis betonicifolia*) and the scarlet creeping rhododendron (*R. repens*). But it is equally the home of many other beautiful flowers, as gentians, lilies, barberries, primulas and many more.—(*Nature*, 19th September 1936.)

FIRE AND VEGETATION.

This very debatable subject has recently been discussed from a very statesman-like point of view by a South African botanist, Prof. John F. V. Phillips (*J. South African Bot.*, 2, Part I). It is pointed out that while such characteristic native vegetation as the beautiful "fijnbos" (the macchia or maquis of the south-west Cape) may be irretrievably damaged by fire, and whilst there is every reason for excluding fire definitely from the water conservation areas, yet, on the other hand, there is also clear evidence that controlled firing, carried out at the proper season, may encourage the subsequent establishment of better pasture grasses. Further, it may be argued that absence of fires, coupled with overstocking, has contributed to a marked increase in the prevalence of the woody overgrowth, especially of species of *Acacia*, which has led to a deterioration in the pastoral value of much tree and grass savanna. There is thus evidence of a need for protection of certain land from any type of fire treatment, whilst in other localities an early application of controlled fire treatment is probably desirable. Such a problem requires action by a responsible body, and Prof. Phillips suggests that the Minister of Agriculture and Forestry should act as chairman of a special Commission of Conservation which should formulate a policy and co-ordinate the functions of the various Government departments involved in the carrying out of this policy. Important legal and administrative problems are concerned. The matter is regarded as urgent by Prof. Phillips, who concludes that uncontrolled firing is costing South Africa untold millions and "creating for posterity a most serious state of affairs which no amount of money ever would be capable of putting right."—(*Nature*, 2nd May 1936.)

TUNG OIL IN KENYA.

BY COLIN MAHER

(*Agricultural Officer, Department of Agriculture, Kenya Colony.*)

GENERAL CONCLUSIONS

It appears from the results of the trials made to date that *Aleurites fordii* is not generally suited to Kenya Colony. The reason for this is not clear since the climate

would seem to be somewhat similar—with the exception that snow and frost are absent—to the parts of China in which the tree is grown; possibly the trees suffer from the shortness of the hours of daylight in Kenya.

No figures are yet available for yields of nuts from plantations of any size which are at least five years old. Yields from a few scattered trees of bearing age are not very promising, but these older trees are chiefly in districts which are not likely to be suitable for the tree.

The general standard of the culture of the *tung* trees in Kenya seems to have been low, and ten acres of *tung* oil are to be established at Kitale by the Department of Agriculture in order to determine whether more intensive and careful culture may give better results. One grower in the Kitale District reports that part of his plantation has grown much better than the rest; this circumstance will be investigated in the hope of discovering some clue as to possible relationships of the composition of the soil to the growth rate. It seems possible, however, that the superior growth of these trees, which are about 8 ft. high 2½ years after planting out, may be ascribed to the protection afforded to the *tung* oil by a belt of gum trees.

Reference has been made to the marked variation in growth of *tung* trees in the plantations in Kenya Colony. It is believed that this is due to the genetical variation which has been observed in other countries. Attempts will later be made to graft scions of the more vigorous trees on to root-stocks of the other trees or on to stocks of other species. A farmer in the Trans Nzoia notes that while the aerial growth of his *tung* trees is poor, the root systems seem to be well developed.

On the results of experimental plantations which have been made in Kenya Colony up to the present time no further plantings of *Aleurites fordii* could be recommended; the plantations in the Trans Nzoia possibly may, however, cause these words to be modified during the next two or three years.

It is considered that extended trials should be made of *Aleurites montana*, *Aleurites moluccana* (*or triloba*) and perhaps *Aleurites cordata*.

Very few trials have been made of *Aleurites montana*, since it was thought originally that the climate of Kenya was likely to be much more suited to *Aleurites fordii*. However, the Assistant Conservator of Forests, Eldoret, reported in 1934 that he had 20 trees of *Aleurites montana* in the Kisfim glade in Kakamega forest, planted in 1932, which were 12 ft. high and in a flourishing condition. This station is at an altitude of 5,200 ft. and has an average annual rainfall of 70 in.

There are three or four trees of *Aleurites montana* in the Arboretum at Nairobi. Despite the fact that the rainfall at Nairobi probably is too light for this species these trees at present look quite well. The best tree is 12 ft. high and has a spread of about 10 ft. These trees are five years old from seed and fruited for the first time in 1935.

A very hopeful report was received from Sotik at the end of 1935 with regard to several acres of *Aleurites montana* trees, seed and plants of which were planted in 1932, so that the trees are now 3½ years old. The trees were planted at an altitude of about 5,700 ft. and the average annual rainfall is probably about 54 in. It is stated that "We found that there was no comparison between the *Aleurites montana*

and *Aleurites fordii*. The *montana* has flowered prolifically and the growth is both even and quick, some of the trees being 17 ft. to 20 ft. high, whilst the *fordii* are slow stunted and uneven."

A tree of *Aleurites moluccana* (the candlenut tree) planted, probably in 1927, at the Scott Agricultural Laboratories, Nairobi, has made vigorous growth at an altitude of 5,700 ft., with an average annual rainfall of 40 in. over the last nine years. The annual rainfall is usually about 30 in. This tree was about 18 ft. high at the end of 1935 with a spread of 31 ft. It fruits fairly prolifically.

A farmer at Fort Ternan writes that he has a candlenut tree which is 30 ft. high and came into bearing within six years. This is at an altitude of about 4,900 ft., with an average yearly rainfall of 60 in. The oil obtainable from the nuts of this tree is said to be inferior to linseed oil for varnishes and similar uses. However, the tree, in view of its healthy and strong growth, might be of value as a stock on which to graft scions of the more valuable species of *Aleurites*.

There are also several candlenut trees in the Arboretum at Nairobi. They are about eight years old and have a height of some 30 ft. They fruit regularly but not freely. This tree is very pleasing in appearance and might be of value as a shade tree for cocoa; although it might prove to give too dense a shade, it is certainly worth experimenting with as a shade tree for coffee in Kenya.

It is not believed that *Aleurites cordata* Steud., the source of Japanese wood oil, has been grown in Kenya. (*Bulletin of the Imperial Institute, Vol. XXXIV, No.* 2, April-June 1936.)

WIND EROSION IN SOUTH AUSTRALIA.

Wind erosion is becoming an increasing danger in the semi-arid regions which form the world's chief granaries. In North America, the Argentine and to a less extent in Russia, the fertile prairie soils are rapidly being swept away as the result of destroying the original grass cover. A similar fate is overtaking vast pastoral regions in South Australia, due to overstocking. The gravity of the situation is revealed in a note by F. N. Ratcliffe, received from the Commonwealth Council for Scientific and Industrial Research. The worst erosion has been in the "bush" country, where twelve drought years have so lowered the stocking capacity that overstocking on established farms is now almost unavoidable. Rabbits have added to the evil, the vegetation cannot recover after grazing and natural regeneration of both shrubs and grasses has virtually ceased. Large areas have become barren deserts, and no measures are available for their reclamation. The evil might be checked by adopting a lower stocking policy; but the only hope for the already denuded areas is to introduce parennial exotic plants capable of stabilizing the large sand drifts and withstanding rabbits and a very low and uncertain rainfall. The chance of discovering such plants is remote, and even if discovered, "there would remain the problem of their dissemination through vast areas with no regular growing season and an unimproved capital value rarely exceeding 2s. per acre."—(*Nature*, 29th August 1936.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for September 1936:

IMPORTS

ARTICLES	MONTH OF SEPTEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER Teakwood Siam ..	190	201	14	20,958	19,006	1,747
French Indo-China ..	2,998	20	104	2,47,677	2,045	12,050
Other countries ..	..	..	76	..	..	10,185
Total ..	3,188	221	194	2,68,275	21,051	23,982
Hardwood other than teak—	..	..	..	..	..	..
Softwoods ..	333	1,280	946	24,999	72,850	58,281
Matchwoods ..	..	..	848	..	..	44,125
Unspecified ..	(*b*)	..	..	1,19,762	1,06,575	43,601
Firewood ..	82	27	20	1,234	405	300
Sandalwood ..	18	..	26	3,125	..	7,778
Total value of wood and timber ..	..	..	..	4,17,395	2,00,881	1,78,067
Manufactures of wood and timber— Furniture and cabinet-ware ..	..	.. No data.	..	..	.. No data.	..
Plywood ..	(*a*)	..	206	..	..	50,337
Tea chests ..	..	..	..	1,60,754	2,46,625	2,40,358
Other manufactures of wood ..	..	..	..	1,57,081	2,09,072	90,814
Total value of manufactures of wood and timber ..	..	..	..	3,17,835	4,55,697	3,81,509
Other products of wood and timber— Wood pulp (costs) ..	35,308	15,032	12,199	2,44,913	96,941	86,076

(*a*) Separately recorded from April 1936.
(*b*) Recorded by value only.

IMPORTS

ARTICLES	SIX MONTHS, 1ST APRIL TO 30TH SEPTEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER Teakwood Siam ..	2,864	202	735	2,72,992	19,061	94,738
French Indo-China ..	2,998	425	1,868	2,47,677	49,479	1,91,707
Other countries ..	..	..	542	..	22	66,505
Total ..	5,862	627	3,145	5,20,669	68,562	3,52,950
Hardwoods other than teak— ..	..	..	..	..	..	..
Softwoods ..	5,521	5,665	8,757	3,68,487	3,49,008	5,26,530
Matchwoods ..	(a)	..	5,430	..	..	2,92,226
Unspecified ..	(b)	..	..	7,17,561	8,55,875	1,89,805
Firewood ..	360	286	167	9,553	4,298	2,499
Sandalwood ..	196	143	119	61,756	50,387	37,530
Total value of wood and timber ..	..	..	..	16,78,026	13,28,130	14,01,540
Manufactures of wood and timber— Furniture and cabinet-ware ..	..	.. No data.	..	..	.. No data.	..
Plywood ..	..	..	1,512	..	..	3,41,641
Tea chests ..	..	..	..	20,13,965	22,98,616	21,73,358
Other manufactures of wood ..	..	..	..	10,18,247	12,32,945	7,28,804
Total value of manufactures of wood and timber ..	..	..	..	30,32,212	35,31,561	32,43,803
Other products of wood and timber— Wood pulp (costs) ..	1,98,634	1,83,032	1,06,583	13,31,260	12,10,198	7,00,048

(a) Separately recorded from April.
(b) Recorded by value only.

EXPORTS

ARTICLES	SEPTEMBER					
	Quantity (Cubic Tons)			Value (Rupees)		
	1934	1935	1936	1934	1935	1936
Wood and Timber						
Teakwood						
To United Kingdom ..	2,459	4,506	3,699	4,75,996	8,85,277	7,50,473
,, Germany ..	48	805	265	10,914	1,83,624	67,062
,, Belgium ..	27	176	..	6,531	29,333	..
,, Iraq ..	67	160	38	10,661	27,803	6,798
,, Ceylon ..	6	62	109	780	7,770	13,508
,, Union of South Africa ..	355	470	782	76,380	75,693	1,67,650
,, Portuguese East Africa ..	75	256	181	12,479	43,800	31,296
,, United States of America ..	..	42	201	..	10,950	59,420
,, Other countries ..	82	565	365	16,812	1,04,642	85,090
Total ..	3,119	7,042	5,640	6,10,553	13,68,892	11,81,297
Teak keys ..	301	455	347	45,117	66,600	46,591
Hardwoods other than teak ..	36	271	195	3,901	27,849	19,354
Unspecified ..	..	..	..	18,124	29,329	35,210
Firewood ..	..	..	..	..	..	..
Sandalwood—						
To United Kingdom ..	..	1	2	..	1,500	2,000
,, China (excluding Hong-Kong) ..	7	..	12	14,840	..	14,130
,, Japan ..	..	24	15	..	24,966	39,303
,, Anglo-Egyptian Sudan ..	3	5	9	2,920	5,900	10,350
,, United States of America ..	50	136	50	60,000	1,37,920	50,000
,, Other countries ..	1	4	1	2,061	2,974	1,790
Total ..	61	170	89	79,821	1,73,260	1,17,573
Total value of wood and timber ..	..	..	..	7,57,516	16,65,930	14,00,025
Manufactures of wood and timber—	..	..	..	6,160	4,111	6,851
Furniture and cabinet-ware ..	..	..	..	No data.		
Other manufactures ..	..	..	..	No data.		
Total value of manufactures of wood and timber ..	..	..	..	6,160	4,111	6,851
Other products of wood and timber ..	..	..	..	No data.		

EXPORTS

ARTICLES	Six months, 1st April to 30th September					
	Quantity (Cubic Tons)			Value (Rupees)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood						
To United Kingdom ..	13,721	16,502	20,373	31,44,666	32,10,231	42,00,784
,, Germany ..	1,216	2,958	1,990	3,00,352	6,87,384	4,76,480
,, Belgium ..	225	508	219	44,823	95,979	34,248
,, Iraq ..	494	669	326	98,355	1,19,025	61,624
,, Ceylon ..	252	398	597	30,043	50,254	78,238
,, Union of South Africa ..	1,953	1,846	3,093	4,44,606	3,02,711	6,28,118
,, Portuguese East Africa ..	124	533	881	22,302	93,898	1,49,411
,, United States of America ..	96	256	335	28,576	62,728	98,030
,, Other countries ..	2,230	2,328	2,935	4,11,968	4,36,238	6,30,856
Total ..	20,311	25,998	30,749	45,25,691	50,58,448	63,57,789
Teak keys ..	1,902	2,239	1,939	2,66,969	3,29,177	2,76,630
Hardwoods other than teak ..	492	392	890	49,492	39,866	93,754
Unspecified ..	..	..	..	1,37,563	2,05,737	2,58,192
Firewood ..	1	28	..	6	425	..
Sandalwood—						
To United Kingdom ..	22	12	5	28,950	14,560	4,600
,, China (excluding Hong-Kong) ..	35	8	52	58,185	11,700	62,560
,, Japan ..	24	49	31	28,838	52,299	58,803
,, Anglo-Egyptian Sudan ..	25	39	40	26,495	45,845	47,400
,, United States of America ..	230	224	284	2,70,000	2,27,480	3,12,648
,, Other countries ..	11	25	34	22,466	29,161	47,356
Total ..	347	357	446	4,34,934	3,81,045	5,33,367
Total value of wood and timber—	..	..	..	54,14,655	60,14,698	75,19,732
Manufactures of wood and timber—	..	..	..	71,235	47,556	48,925
Furniture and cabinet-ware ..	..	..	..		No data.	
Other manufactures ..	..	..	..		No data.	
Total value of manufactures of wood and timber ..	..	..	..	71,235	47,556	48,925
Other products of wood and timber ..					No data.	

THE CULTIVATION OF EXOTICS IN KULU

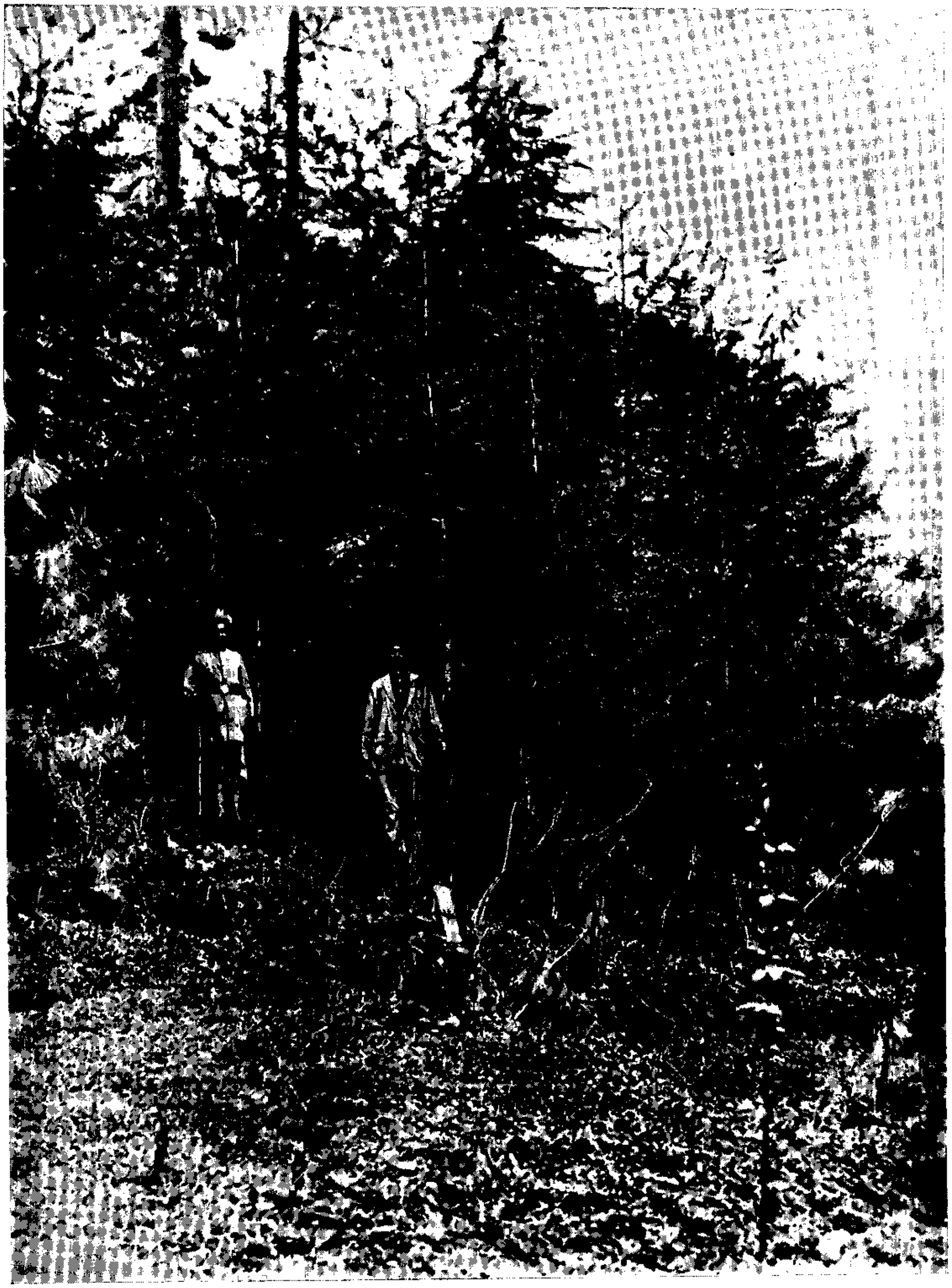
BY W. T. HALL, I.F.S.

Summary.—This paper is divided into two parts. Part I deals with the problem, with notes on pioneer work and recent experimental work with exotics in Kulu, Punjab. Zones of tree vegetation in the Kulu hills are shortly described. It discusses the question of policy and the problem in the fir zone and in the *chir*—lower deodar zone. Part II gives notes on the results of the experiments with the various exotics tried.

PART I.—THE PROBLEM.

The Inspector-General of Forests has ordered me to write a paper on the above subject. This explains what might otherwise be considered a presumption on my part in writing a note on this subject at all.

I toured in the Kulu division for five weeks, but the cultivation of exotics is chiefly centred at Manali, where I only halted for eight days. During this halt, in addition to my other work, I had to spend a good deal of my time correcting 300 qualifying examination papers for the next Rangers' Course. Under the circumstances inaccuracies are almost inevitable, but I trust these are not serious.



LARCH (LARIX LEPTOLEPIS), 11 YEARS OLD, PLANTED BY MR. TREVOR IN NAGNI BLOCK, 1916

Photo : R. Banerjee.
12-5-1927.

Pioneer work—Most of us have a desire to grow somthing. A few of us have an urge to introduce a foreign species, very often merely to see how it will do. Fewer still cultivate exotics with some definite sound object in view. Of the latter band of enthusiasts was Mr. Trevor who was Divisional Forest Officer of Kulu division for nine years up to 1919. Exercised as he must have been with the routine duties of a large and important division ; faced with the problem of regenerating a large tract of valuable deodar forest—a problem which he ultimately solved—he still found time to interest himself in the introduction and cultivation of a number of exotics. Since this pioneer effort little seems to have been done until 1931.

Recent experimental work.—Unfortunately a good deal of the detailed data of Trevor's experimental work has been lost although a certain amount of information is still available in the compartment histories. I think it would be worth while collecting all available data by species.

From 1931 the experimental work on exotics in Kulu was placed directly under the Provincial Silviculturist, and an adequate record of all work since that date has been maintained. So much can be said for concentrating experimental work in the hands of a research officer that the importance of interesting the Divisional Forest Officer in such work is often lost sight of. This, I think, is particularly important in such experimental work as the cultivation of exotics and I suggest that some means should be devised to ensure that the Divisional Forest Officer will have an active part and not merely a passive interest even in the experimental stages. He should, I think, at least participate in the experimental work in the forest after the nursery stage and be ultimately in sole charge of what is referred to as the Class II experimental stage, which has not yet been reached in Kulu.

Policy.—I have shown that an adequate record and continuity in the actual experimental work is now assured, but this is not enough. On the subject of the introduction of exotics there is often considerable difference of opinion amongst forest officers. With changes in the

administrative staff, the experimental work might be closed down and much valuable time and money might easily be lost. In the face of a well-reasoned general note explaining what the problem is and what policy has been approved by higher authority, it would not be easy for a change of staff to bring about a change in policy, unless it was based on facts as a result of experience and not merely on a difference in opinion. I have no intention of giving my opinion on the question of policy, but the absence of such a general note on the problem by some one more qualified to deal with it is, perhaps, the only justification of my attempting to explain it.

What is the problem? Why is it considered necessary to introduce exotics? Is this the only means or likely to be the best means of solving the problem? No country, with the possible exception of South Africa, has gone in more for the cultivation of exotic conifers than Great Britain. But with them the answer is easy—in their case it was Hobson's choice. Great Britain had only one indigenous conifer of value for its afforestation—the Scots pine. South Africa, faced with the problem of afforesting immense, almost treeless tracts had only one indigenous genus of conifers (the *Podocarps*) which did not nearly meet their requirements. Such is not the case in Kulu with their forests of Silver fir, spruce, deodar, *kail* and *chir* pine.

The working plan is completely silent about exotics, past or future, and actually seems to indicate that their introduction is not recommended, *e.g.*, in para. 44: "Thus again has nature triumphed over man and again has silviculture been vindicated. Man working in co-operation with nature can attain great success; if, on the other hand, he should attempt to override her laws, *to obliterate the species of her choice and to supplant it by another of his own, failure will very probably result.*" (The italics are mine.) I do not wish to stress the importance of a quotation taken from a context not specifically dealing with this subject but merely wish to show that the working plan does not recommend experiments with exotics nor does it deal with the relevant problem.

The chief objects in experimenting with exotics in Kulu appear to be:

Object 1.—To find a conifer as good as deodar which can be grown successfully at higher elevations in the fir zone.

Object 2.—To find a suitable hardy species, economically valuable, for the *chir-ban* oak zone and for the lower deodar zone where artificial regeneration of deodar has failed.

Zones of tree vegetation in Kulu.—For the proper understanding of the reasons behind the cultivation of exotics in Kulu, it is necessary to have a fairly intimate knowledge of the silviculture and economics of the main species in this locality which I do not pretend to be thoroughly conversant with. For the sake of completeness I might mention the main zones of tree vegetation in Kulu.

(*i*)—THE CHIR ZONE

This zone is not important in Kulu and is usually absent; but it might be of interest to mention that we saw *chir* in the Parbatti valley of very good quality at an elevation of 6,500 feet to 7,000 feet. This would be high for good quality *chir* in the United Provinces. It was occasionally found growing well on exposed sites above deodar of good quality in the same area.

(*ii*)—DEODAR-KAIL ZONE (5,000—8,000 feet)

These species are found pure or more often in association, but the *kail* is generally more common than the deodar. This forest forms by far the largest part of the Regular working circle, worked under a Shelterwood compartment system. Spruce sometimes extends down to this zone and may even be found pure in the higher parts of the zone, particularly on a cold aspect or in damp areas unsuited to the deodar and *kail*. The *kail* sometimes appears again for some extraordinary reason at much higher altitudes (up to 11,000 feet) associated with Silver fir.

(*iii*)—FIR ZONE (SPRUCE AND SILVER FIR) (8,000—12,000 feet)

These species form magnificent forest with stems up to 200 feet high and of large girth. Fourteen per cent. of the stocked coniferous area of the Regular working circle still consists of fir forest,

but by far the largest area of most accessible fir forest is allotted to the Fir working circle. Generally such forest has a more or less even-aged appearance and the crop is often mature or overmature. A large percentage of the big trees produce unsound timber. A uniform system of management is prescribed, but owing to the collapse of the fir market little progress has been made. At higher altitudes the fir forests have a much more irregular appearance and are allotted to the Selection or the Unregulated working circles.

THE PROBLEM IN THE FIR ZONE

The more I saw of these splendid forests in the fir zone the more was I impressed with the need to have a very good case indeed before adopting a policy of replacing them to any great extent with foreign species. The possible reasons are both economic and silvicultural.

Economic reasons.—Fisher's working plan of 1897-98 never even considered the export of spruce and silver fir as a commercial proposition. Trevor's plan of 1919-20 mentions that the export of fir had now commenced, but emphasises that efforts must be made to place the possible outturn of fir upon the market. But, up to 1930, fellings of fir were in deficit even in the Regular working circle to the extent of 75 per cent. due to the lack of a market. In the Fir working circle, fellings were about 96 per cent. in deficit. Samler's working plan of 1934-35 says, "at present fir cannot profitably be exported for the open market." I understand that at the moment there is a slight improvement, but I think one would be justified in saying that the demand for fir is exceedingly poor and its prospects as far as one can see are far from bright.

The railway sleeper orders are at present supporting the market, but even these cannot be considered a stable demand for the future and I was surprised to find that the total railway order of wooden sleepers from the Punjab was so small. In the agreement with the North Western Railway ending 1938-39, the Railway has agreed to accept from the whole Province annually :—

Deodar sleepers—10,000. Fir sleepers—20,000.

Prices at Dhilwan are : Deodar, Rs. 4-15-0 and Fir, Rs. 2-15-0 each.

TYPICAL SPRUCE AND BROAD-LEAF FOREST AT 8,000 FT. NEAR PULGA IN THE PARBATTI VALLEY, WITH OCCASIONAL BIG KAIL AND SILVER FIR

Photo : R. M. Gorrie.

DOUGLAS FIR, 11 YEARS OLD, PLANTED BY MR. TREVOR IN 1916

Photo : R. Banerjee. 21-5-1927.

The sleepers are creosoted and recently the Railway reported that if it failed to perfect its preservative treatment it would cease to take fir sleepers as from 1936. I understand that the treatment is giving better results than anticipated but is still not perfect. Success with the cheap creosoted fir militates against the use of the more expensive deodar and the metal sleeper militates against the demand for both.

When the large possibility of the fir forests is considered, the present railway demand must be considered exceedingly small even if it continues. Moreover, the specification is severe and the price low, and if all legitimate overheads are included, the net profit to the Forest Department must be a very small margin.

The present conditions in the open fir market are much worse. With the heavy rejections of railway sleepers there is even difficulty in disposing of rejected sleepers and those not fit for presentation to the Railway. In the event of the Railway failing to take fir sleepers it is unlikely that we could sell more than 20,000 c.ft. of fir timber in the general market.

With such conditions in the fir market, is it to be wondered at that certain forest officers are anxious to find another species for the fir zone of greater economic value ?

Another, but less important, reason is that mature spruce often contains a red heartwood, the causes of which are unknown, which makes the timber useless for export.

It would be idle to deny that the economic problem is not a pressing one, but there does not appear to be unanimous opinion amongst Punjab forest officers that the best solution is to introduce exotics. I have heard of no other solution, but it will at once occur to anyone that it might eventually be equally sound to spend money in trying to create a larger fir market, a solution fraught with great difficulties, which, at the best, would be very slow and which has been found to produce little result with better timbers than fir. On the other hand we can scarcely expect to produce better results from an exotic in less than 80 years, and who can foretell what the condition of the fir market in India will be like in 80 years time ? The general

tendency is likely to be towards a much greater demand for softwoods in India, not necessarily at the expense of the existing demand for hardwoods.

A better solution would be for Government to force its own Railways to increase their wooden sleeper orders from its own forests. I do not intend to tread far along the well-worn paths of this controversy. But here we have thousands of fine trees destined to rot in the forest. For protection purposes alone it is the duty of Government to regenerate these forests and, if necessary, Government will have to go to very considerable expense getting rid of the overmature stock to do so. The problem is not an easy one, but I am not prepared to believe that it would not be a sound economic proposition for Government to make a vast increase in their wooden sleeper order at the expense of steel sleepers without the State decreasing its support of the Indian steel industry to any very material extent.

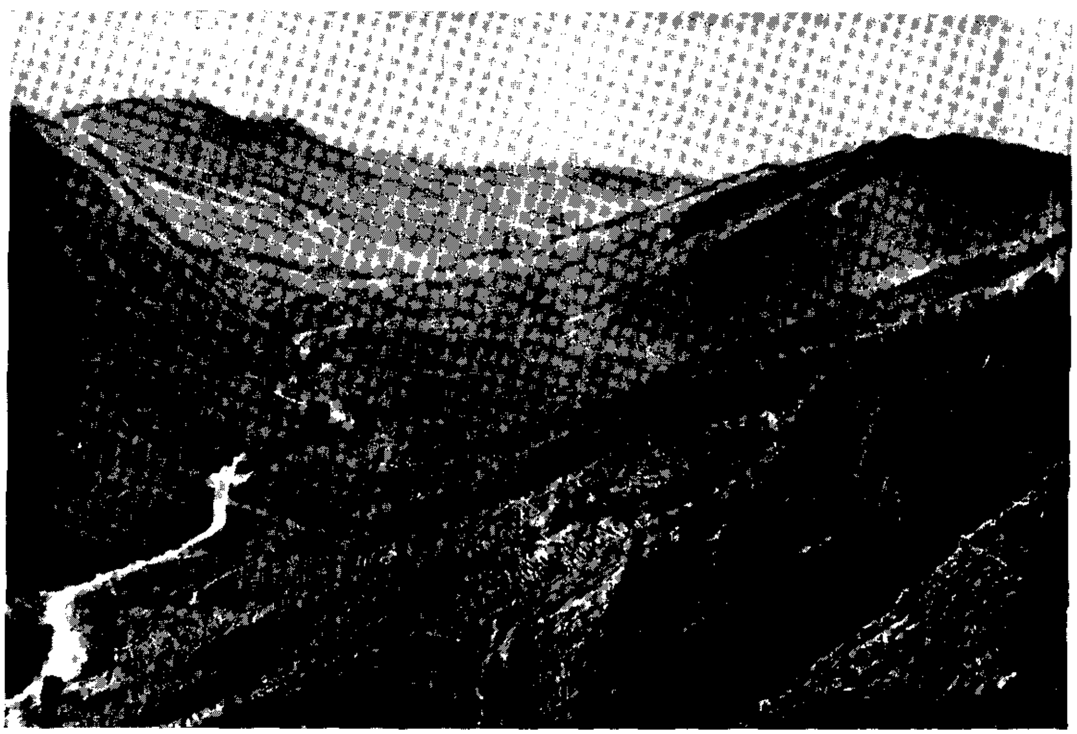
Silvicultural reasons.—There are also silvicultural reasons to justify the introduction of exotics in the fir zone, for even if the market could immediately absorb the total yield of fir, fellings might be held up through failure to obtain regeneration. Few species are as bad as spruce and silver fir for creating bad regeneration conditions for themselves through the accumulation of humus from their own needles.

It is possible that the regeneration of fir is sufficient in the irregular type of forest at high elevations, but it is generally absent or scanty in virgin forest in the median areas of the fir zone.

Another factor besides that of the excessive humus layer is the dense growth of *strobilanthes* and balsam, particularly in damp areas. Management is further complicated by the great vulnerability of fir to fire damage and we saw mature fir killed by fire even after the carefully-controlled slash burning in experimental plots.

Further, the growth of the local fir in the seedling and sapling stages is so slow that regeneration is bound to be expensive in areas of heavy weed growth and any exotic of faster growth in the early stages might be a profitable proposition even if the timber proved of no greater economic value than the fir.

ALPINE MEADOW AT 9,000 FT. IN THE PARBATTI WITH A SOMEWHAT DRY TYPE OF KAIL FOREST BEHIND. TOSH NAL IN CENTRE BACKGROUND *Photo: R. M. Gorrie.*



THE MAIN VALLEY OF THE BEAS BELOW KULU, SHOWING BARE AND OVERGRAZED LOWER SLOPES WHERE DEODAR IS DIFFICULT TO RE-ESTABLISH. NAGNI FOREST IN RIGHT DISTANCE. *Photo: R. M. Gorrie.*

The problem of the regeneration of fir is an item of research under the Silviculturist. Present experiments with humus removal followed by sowings and also transplanting big strong plants from nurseries are promising. It is possible that if a better market had induced regular fellings in the true fir zone, followed by closure to grazing, that the problem would have been solved before now; but, whatever the ultimate solution, regeneration will probably never be easy and expenditure on artificial work will be necessary. It could, therefore, be argued that it would be better to cultivate an exotic of greater economic value than the fir with the same or with little increase in the expenditure.

THE PROBLEM IN THE CHIR AND LOWER DEODAR ZONE

This problem is comparatively of only minor importance in the Kulu division. I have already mentioned that the *chir* zone in Kulu occupies a very small area. Moreover, the working plan mentions that where *chir* crops occur, profuse natural regeneration has followed regeneration fellings. I understand, however, that in the neighbouring Kangra division where *chir* forms the chief crop, great difficulty has been experienced in some places in regenerating the forests either naturally or artificially particularly at its highest and lowest altitudinal limits.

In the Kulu division small blanks often occur at the foot of the deodar zone in which great difficulty has been experienced in introducing deodar or *kail*. This may be due to unfavourable soil conditions, but it is partly due to excessive grazing.

We inspected one such area in the Rahni forest near Manali, a blank of 20 acres, obviously very heavily grazed. It strikes one at once as an area where one would naturally try to raise deodar or *kail*. I am not at all convinced that it could not successfully be planted up with deodar. Alongside of it, on ground with the same aspect, an excellent plantation of deodar has been raised. Unsuccessful efforts to introduce deodar and *kail* were made before the area was fenced against cattle or before the soil had time to recover from the effects of previous heavy grazing. In the last year or two a

small area in the upper part of the blank planted up with deodar by the divisional staff promises success. In this particular area at least better reasons would have to be adduced for introducing exotics.

A reason which could be advanced against the stocking of such areas in Kulu with the low-level pines which are being tried is that they would greatly increase the difficulty of fire-protecting the valuable deodar forest on the hills above.

The research point of view, however, is that their work in the Rahni forest is chiefly experimental and even if the results proved to be of little value for the Kulu division they might be valuable for the Kangra division. It might be better perhaps to conduct the experiments with the low-level pines in Kangra.

The species which are being experimented with in the Rahni forest are :

Pinus taeda ; P. pinaster ; P. laricio ; P. sylvestris ; P. gerardiana ; P. patula. Cryptomeria japonica and Douglas fir were also tried but failed. Of the pines the most promising is *P. taeda*, but easily the most promising species so far is *Cupressus torulosa*, a species whose natural habitat is mainly in a monsoon climate with heavy summer and low winter rainfall, but here growing well on a warm southern aspect at 6,500 feet elevation with a small total rainfall (about 40 inches), almost half of which falls between December and April. It is, however, too early to judge results as planting only started in 1934.

Pinus taeda (Loblolly pine).—Of 150 plants put out in 1934, only 18 now survive, but these are strong and healthy-looking with an average height of about 30 inches. Of the 40 plants put out in 1935, 63 per cent. have survived and are promising. Plants put out in the pinetum at Manali in 1935, with an average height of 8 inches, now have an average height of 26 inches and the percentage of survivals is high.

Cupressus torulosa.—Of 517 plants put out in 1933 and 1934, 40 per cent. have survived. They have an average height of 18 inches and are strong, healthy-looking plants.

PART II.—RESULTS OF EXPERIMENTS WITH EXOTICS IN THE FIR ZONE

I do not intend to give a mass of details about the large number of exotics under experiment but merely to give a few notes on certain species and on certain matters which struck me as being of general interest. Details of results can be obtained from the Silviculturist's files, but it must be remembered that these only deal with experiments started since 1932. I suggest it would be worth while collecting all information that is available of the earlier work by species from compartment histories and from any other source. I would also like to suggest that every possible chance should be given to such exotics as have survived from the earlier work. For instance, one Douglas fir has been killed recently by suppression of *kail* in the upper plot in Nakas, C. 1.; a mature spruce is casting too much shade over the lower plot of larch and Douglas fir in the same compartment and should be removed. I would also prefer to remove more mature trees along the edge of the larch experimental plot No. 20, as larch dislikes any kind of shade.

Pure spruce in deodar Zone.—With one exception which I shall mention later, I would like to emphasise that experimental work in the forest should be restricted to the true fir zone. Two of the most interesting plots seen are larch planted by Trevor in 1917. I refer to the plots near Nagni bungalow and to the lower plot in the Nakas forest near Pulga. In both of these plots the larch are very promising, but they are on sites and at an altitude at which good quality deodar can be raised and is actually growing just as successfully. Even the most ardent enthusiast for exotics would hesitate to recommend the cultivation of an exotic on sites suitable for good quality deodar. And it cannot be accepted as an indication that the exotic will do well in the true fir zone because it is successful in the deodar-kail zone, although it may be so.

The exception to which I refer above is where spruce occurs pure in the deodar zone, chiefly in damp areas obviously unsuited to deodar or kail, but necessarily included in the Regular working circle.

Where spruce occurs in the dry parts of the deodar zone it is being replaced artificially with great success by deodar.

Where spruce occurs pure or mixed with broad-leaved species in the damp areas of the deodar zone, the regeneration of the forests must be considered as a separate problem. Whatever methods are tried the problem might possibly be as difficult with exotics as with the indigenous species. It is in just such areas that one would introduce spruce in Europe and where one certainly would not attempt to cultivate larch.

I am not at all sure that I would not prefer to preserve the natural forest in such areas (damp low-level spruce areas of the deodar zone) in spite of the economic disadvantages of doing so. I think that the regeneration problem of spruce will be solved by using strong, healthy transplants and scraping away the humus layer. As this will be expensive and as a species like *Thuja plicata* might be easier to grow, one may well ask, "Why not introduce exotics?" Experiments with exotics have not yet been started in such areas but they will have to be species suitable for damp sites. Species that come to mind are Sitka spruce, *Thuja plicata*, *Taxodium distichum* and possibly *Cupressus torulosa*.

Whether exotics or the indigenous spruce are planted, a method that might be tried in suitable places is that used extensively in Scotland. A line of turf is taken out vertically in small squares forming a shallow drain. The turf is reversed and put out where you wish to plant. The plant is put in through a hole in the centre of the turf. It would probably be necessary to remove the humus before placing the turf on the site of the plant.

In such areas it is said that natural regeneration of spruce comes up best under broad-leaved species. In a spruce area in Nagni, following erosion caused by a severe fire, we saw *Populus ciliata* invading damp nalas. *Kail* had begun to regenerate under the poplar. It is said to be more difficult to raise the indigenous poplar from cuttings than several foreign poplars which are now being experimented with. When cuttings are available they will be put out in the open damp fir forest with heavy *Strobilanthes* and balsam

undergrowth. It is hoped that the weeds will be suppressed by the poplar and that fir regeneration will come in naturally. Poplar cuttings will also be tried for stocking the *bihals* (fresh alluvium deposits in the river beds). Some of the foreign poplars being experimented with are: *P. generosa, P. monilifera, P. serotina, P. regenerata, P. eugenii*. For the same reason some of the local broad-leaved species are being put out in the fir zone, *e.g.* walnut and alder.

Nurseries.—Before giving notes on some of the foreign species being experimented with in the true fir zone, I might mention the nurseries, which I think are quite inadequate to produce sufficient stock even for the experimental stage. There is a tiny little nursery at Pulga where they are raising plants of European larch and *Thuja plicata*. There are two larger nurseries at Manali covering above 1¾ acres, but a large part of the latter are not used for raising stock for the cultivation of exotics in the fir zone. Part is used for raising the exotic low-level pines, a work which I have already suggested might be more suitably transferred to Kangra division. Part is used for raising transplants of the indigenous spruce, silver fir and deodar; part to raise plants of *Acacia dealbata* to stock the *bihals* of the river beds. In fact only a small part of the Manali nurseries is at present being used to raise a stock of exotic conifers for the fir zone.

These nurseries are kept in very good order for Indian conditions and my chief criticism is that plants have not been kept long enough in the nursery. Transplants used so far have generally been far too small, a fact which is now recognised. The staff have been too anxious to see results in the forest. It would, I think, have been better to concentrate first on developing a sound nursery technique and on raising big, strong, healthy transplants. In 1934, when transplanting in the forest was first started, no transplant was more than 18 months old. Even in the present year, transplants have rarely been more than 2 years old and I saw plants that had been put out not more than 4″ high, plants which a Scottish nurseryman would have burnt rather than send them out to the forest. In Scotland, plants are sometimes kept in the nursery for 5 years after pricking out in the

nursery twice (2+2+1 year transplants). *It is probable that under* Kulu conditions most of the foreign conifers which have been tried (except the low-level pines) should have been kept in the nursery for *at least* 3 years to produce good results in the forest. *If this is done,* it will be additional reason for creating larger nurseries for cultivation of the exotic conifers.

Before giving the following notes on some of the exotic conifers experimented with, it must be remembered that, except where otherwise stated, transplanting in the forest only dates from 1934 and it is, therefore, too early yet to come to even a preliminary decision as to their suitability.

NOTES ON CERTAIN SPECIES

Note—Fairly recently, the Botanists in their usual irritating way, have changed the names of certain well-known conifers with whose names we were all familiar and to avoid confusion, I give the new and old names here.

New name.		*Old name.*
Picea abies (Norway spruce)	..	*P. excelsa.*
Larix decidua (European larch)	..	*L. europea.*
Larix kaempferi (Japanese larch)	..	*L. leptolepis.*
Pseudotsuga taxifolia (Douglas fir)	..	*P. douglasii.*
Abies alba (European silver fir)	..	*A. pectinata.*
Abies spectabilis (Himalayan silver fir)	..	*A. webbiana.*

EUROPEAN LARCH (L. DECIDUA)

Mountains of Central and N. Europe, introduced extensively in Great Britain, particularly in Scotland. One of the most profitable of all conifers.

Trevor first planted out European larch in Nakas forest near Pulga in the Parbatti valley in 1917 and in the same year at Nagni.

Nagni plots.—Several hundred transplants were put out at an elevation of 7,500 feet and were reported to be thriving until the disastrous fire of 1921 destroyed all except a group of 15 trees (Plot 54) near the Forest Rest House, and a group of 20 trees (Plot 55) above the forest road.

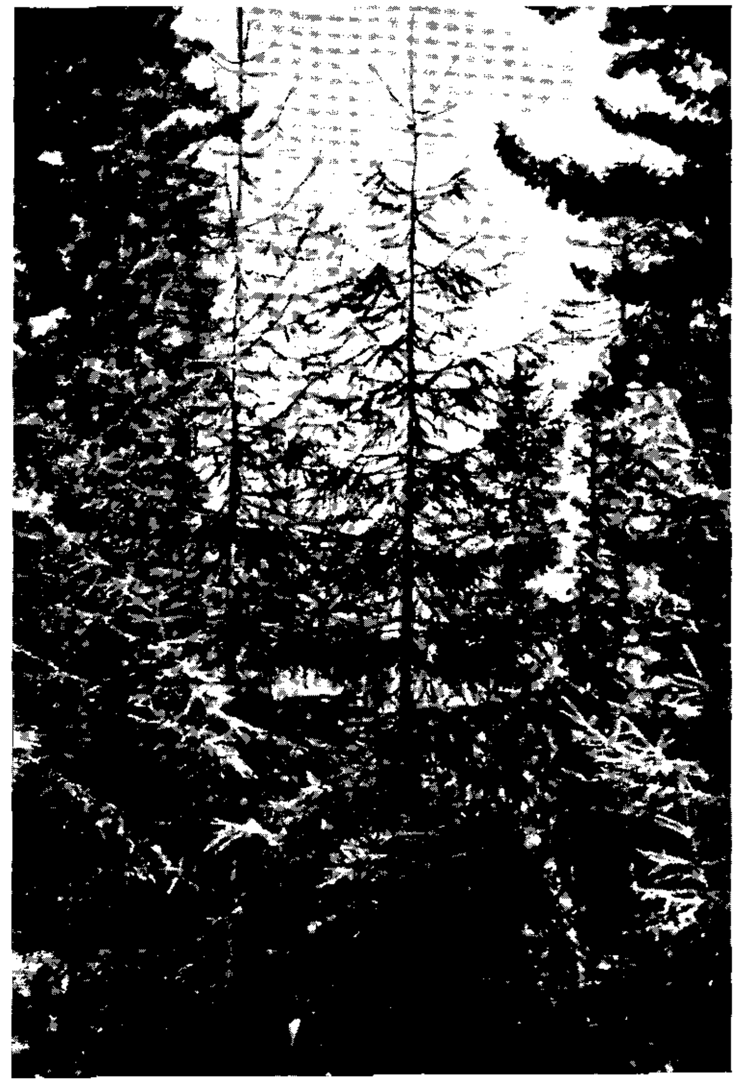
Plot 54—

Age, 19 years.

Average diameter at 4′ 6″ = 6 inches.

Average height = 45 feet.

LARCH AND DOUGLAS GROUP IN THE UPPER NAKAS PLANTATION OF 1917, SOMEWHAT OVERSHADOWED BY A SINGLE BIG KAIL TREE



EUROPEAN LARCH IN THE LOWER NAKAS PLANTATION OF 1917

Photos : R. M. Gorrie.

For comparison the following figures are taken from the British Forestry Commission's Yield Table for European larch, Quality Class II:

Age, 25 years.

Average diameter at 4′ 3″ = 5·4 inches.

Mean height = 40 feet.

These figures show that the growth in the Kulu plot is exceedingly fast. They are fine, healthy-looking young poles and very promising.

Plot 55—

Age, 19 years.

*Average diameter = 4 inches.

*Average height = 30 feet.

The growth in this plot is not so good, said to be due to domination by surrounding spruce and *kail* which have since been removed.

Nakas plots—There are two plots here, the upper at 9,000 feet elevation with 22 trees, the lower at 8,000 feet with 10 stems. I think these plots contain some stems of *L. kaempferi* (Japanese larch) but I am not sure. No experimental plot files have been opened for these two plots and I suggest that this should now be done.

Upper plot—

Age, 19 years.

Average height = 25 feet.

Average diameter = 3·5 inches.

Best stem, diameter = 5 inches.

Best stem, height = 33 feet.

I was particularly interested in this plot as it is definitely in the true fir zone whilst all the other plots are in the upper deodar-kail zone where deodar are being raised artificially with great success. As will be seen from the above figures, growth is very satisfactory though not so good as at lower elevations. It is also quite possible that growth has been affected by the shade of surrounding trees in the past to which larch is very intolerant. There are still mature *kail* and spruce shading the young larch which I consider are affecting the growth of the larch and should be removed.

* Excluding six badly suppressed stems.

I think that the results already justify further experiments with larch in the true fir zone on a much larger scale than at present.

Lower plot—

Age, 19 years.

Average diameter = 4 inches.

Average height = 32 feet.

Recent experiments.—We also saw recent experiments with European larch, dating from 1934, in the Nakas forest near Pulga, the Kangni forest above Manali and in the Manalgar forest near Manali, all situated in the true fir zone. I thought all were quite promising considering that the transplants used were all too young and too small. I give below some figures for the Nakas experiments at an elevation of 9,000 feet as an illustration :

1934—

200 plants put out in July at 6′ × 6′.

Survivals in October 1936 = 60 per cent.

Average height in October 1936 = 12 inches (Best 24 ins).

1935—

106 plants put out in July at 10′ × 10′.

Survivals in October 1936 = 94 per cent.

1936—

115 plants put out in July at 10′ × 10′.

Survivals in October 1936 = 96 per cent.

I think it was a mistake with larch to increase the spacing to 10′ × 10′.

Experiments with pretreatment of larch seed soaked in cold water for periods up to 72 hours were not significant and no previous treatment appears to be necessary ; but soaking the seed in hot water till it swells might be useful. Planting at the beginning of the rains is probably best.

DOUGLAS FIR (PSEUDOTSUGA TAXIFOLIA)

British Columbia to California, etc. Along with other conifers of the Pacific coast (Sitka spruce, several *Abies*, *Thuja* and *Tsuga*) created quite a revolution in British forestry, but of recent years has rather fallen out of favour in Great Britain. With 8—10 rings to the inch is an excellent timber.

This species was transplanted by Trevor in Nagni and in Nakas along with larch in 1917. I did not see any at Nagni and they must have been killed by the 1921 fire or have disappeared for other reasons. In the lower plot at Nakas at an elevation of 8,000 feet there are still 11 stems with an average diameter of 3·5″ and an average height of 23 feet. The best stem is 5·7″ with a height of 33 feet. This is quite good growth in 19 years. There were two suppressed stems in the upper plot one of which has since been killed by suppression.

Recent experiments.—In October 1934, 220 plants were put out in the fir zone at Kangni when 15 months old and none have survived.

In August 1935, 400 transplants were put out and have not done well, only 86 surviving now. But the plants were only 16 months old and were put out too late. Plants were at one time kept in the nursery in Perthshire till they were 5 years old when they were big, strong plants 2½ feet high. It is still the usual practice to use 4-year-old transplants on sites with much bracken.

In July 1936, 300 more plants were put out and these were bigger, 2¼ years old. The recent work with Douglas fir is not promising, but the old plot referred to above is certainly encouraging and I would like to see further experiments with this species, using older and bigger transplants.

Thuja Plicata (Western Red Cedar)

Alaska to N. California and Montana. It is said to resist damp better than any other conifer with the exception of *Taxodium distichum*, Nootka cypress and the yew. In forests in its own habitat attains a diameter of 3 to 8 feet and a height of 125 to 175 feet. The timber has a worldwide reputation for durability but is not suitable for beams with heavy loading.

This is so far one of the most promising exotic conifers tried in Kulu in recent experiments.

In Kangni forest.—200 plants, 16 months old, were put out in August 1935. In July 1936, 141 still survived. The average height is now 11 inches and they look healthy and vigorous. Even with small transplants a fair measure of success is obtained, but I believe a very much higher percentage of success will be obtained if plants are kept in the nursery for another year. These plants were raised

and transplanted in tubes made of galvanised iron, 10 inches long and 3 inches in diameter. The method is expensive and I do not think it should be necessary with this species.

Plants put out in the Manalgarh forest are equally promising as also at much lower elevation in the pinetum at Manali. It is also reported to be doing well at Dharmsala. It is easy to transplant and is likely to be very successful in the true fir zone and also possibly in the damp low-level spruce areas of the upper deodar-kail zone.

I think it would also be worth while experimenting with the Western hemlock (*Tsuga heterophylla*).

Cryptomeria Japonica (Japanese Cedar)

Japan and China, where it attains a height of 150 feet or more with a girth of 20 to 25 feet. In Japan it is the most widely cultivated of all trees for afforestation purposes, thrives well in a damp climate with a fairly heavy rainfall, but appears to stand a wide range of climatic conditions. It has done well at Shillong between 4,000 and 6,000 feet and at Ootacamund. There is a very good group at Deobun (Chakrata) at 9,000 feet. It is now quite naturalised in the Darjeeling District. In Bengal, growth has been more rapid than desirable, producing soft timber, and their problem is to reduce the rate to 5 or 6 rings to the inch.

It would not seem likely that a tree which thrives in a damp climate in its own country and is a success in the humid climate of the Bengal hills would do well in Kulu with its comparatively low total rainfall (about 40 inches). But it is showing great promise nevertheless.

In the fir zone at Kangni 41 plants were put out in 1934 and 50 plants in 1935. Sixty plants have survived, vigorous and healthy, with an average height of 20 inches. These transplants were only 15 and 19 months old respectively, whilst the recent Bengal practice is to keep them in the nursery for 3 years and put them out when 3 or 4 feet high.

This species failed when tried in the low-level deodar zone at Rahni.

I think it would be worth trying in the damp low-level spruce forests.

Other Species

Other species being tried out in the fir zone are:

Picea sitchensis (Sitka spruce).—Out of 159 plants put out in 1935, only 7 plants have survived. Direct sowing in the forest was

also tried but failed. I think this species might be tried again using older transplants in view of its hardiness on poor soils. In recent years it has been planted on a very large scale all over Great Britain.

Larix griffithii (Sikkim larch).—Out of 20 plants put out in 1935, only five plants survived. It was also tried by Trevor in 1917. It was also sown in the nursery at Pulga in 1931, but the seedlings died of frost. I do not see much point in repeating experiments with this species.

Taxodium distichum (Deciduous cypress).—Seven plants put out in 1934 have since died; 25 plants put out in 1936 were looking very healthy.

Picea abies (Norway spruce).—Transplants were only 1½ inches high after being in the nursery for two years. I do not think it would be worth while continuing experiments with this species.

Chamaecyparis obtusa (Hinoki cypress).—Plants put out in Kangni seemed to be doing very well.

At Manali, a broad-leaved arboretum and a pinetum are in process of formation, which should be very interesting. The former already contains several Sweet chestnut (*Castanea sativa*) producing fruit; lime (*Tilia europea*); English and American oaks; beech and ash. All of these broad-leaved exotics are well advanced, from 3 to 7 feet in girth and up to 75 feet high and generally quite successful. The pinetum was only started in 1935 and contains examples of many of the exotic conifers already mentioned.

THE BEGINNING OF TEAK PLANTATIONS IN INDIA

BY M. V. LAURIE, I.F.S.

The natural teak forests on the west coast of India had been very heavily felled over in the late 18th and early 19th centuries chiefly to provide teak timber for building Government vessels at the Bombay Naval Dockyard. The authorities in Malabar began to be anxious about the supply as early as 1828, and during the next ten years great difficulty was experienced in finding sufficient teak timber to meet the annual demand of the dockyards.

In spite of numerous reports to Government, nothing constructive was done until Mr. H. V. Conolly, the Collector of Malabar, put up proposals for acquiring 260 square miles of teak-bearing forest and managing it properly with a small staff for the production of teak. The proposals he drafted were far in advance of any ideas of forest management at the time, and, among other things, he proposed experimenting with teak seed to see if the tree could be raised artificially. Government did not then give him his 260 square miles of forest, but they did permit him to experiment in growing teak, and allowed him to appoint a "Sub-Conservator" on Rs. 150 per month and additional establishment totalling Rs. 51.

Great difficulty was experienced at first in getting teak seed to germinate and a large number of different ways of sowing were tried without success. Transplanting natural seedlings from the forest was also tried but with no better result. The first Sub-Conservator was dismissed on account of unsatisfactory work and a Sergeant Graham appointed in October 1842 on a pay of Rs. 50. He took a keen interest in the work. Agricultural and botanical authorities were consulted, and ideas were collected from the local village officials, and a number of new experiments started.

In April 1843, however, Sergeant Graham resigned his appointment although he was offered an increase in salary. He said that he could not stand the discomforts of the life for himself and his family nor suffer further the indignity of having to take off his trousers before the crowds on the bank every time he had to cross the river. This change of officers was unfortunate at this juncture, but the work was then entrusted to a Mr. Chatu Menon who remained in the post until 1862. A voluminous correspondence exists about these early attempts. Sowing at different times, soaking the seed, cutting off the coat, burning straw over it and a number of other methods were tried. The first person to get a really successful result was the Head Accountant of the Collector's office in Calicut (how often do Head Accountants take to Silvicultural Research in their spare time!). He raised seedlings in a nursery bed with seed that had been previously soaked for 48 hours, sown in April, and the bed covered

1846 TEAK PLANTATION, NILAMBUR, MADE BY MR. H. V. CONOLLY, COLLECTOR OF MALABAR, AND PRESERVED IN HIS MEMORY. THE SIZE OF THE TREES CAN BE JUDGED FROM THE FIGURE AT THE BASE

Photo : H. G. Champion.
January 1934.

with straw laid over with twigs, and watered daily. This method, with very little alteration, is the method used to-day. Early germination took place, and, at the break of the rains, the seedlings were planted out in a clearing, and watered on dry days when there was no rain. The result was magnificently successful.

The locality chosen for the plantations on the bank of the Chaliyarpuzha, could hardly have been more favourable had Mr. Conolly searched the length and breadth of India. With a rainfall of 120 inches, a temperature of 85 to 95, a high atmospheric humidity and a rich alluvial soil, the young teak grew at an amazing rate.

It is interesting that the method of transplanting entire seedlings, started by Mr. Conolly and continued up to 1933 or 1934, is now regarded as the least satisfactory method of raising teak plantations. It has now been replaced by stump-planting or, in favourable areas, by direct sowing of pretreated seed.

From 1844 onwards the plantations were extended regularly by about 100 acres a year, a rather wonderful performance considering the staff available. They are now in their second rotation, the first plantations of 1843 to 1845 being clear-felled in 1917-1919. A portion of the 1846 plantation was saved from felling and preserved as a memorial to Mr. Conolly.

Such is the history of the Nilambur teak plantations which for many years were known as the Conolly teak plantations, in memory of their founder. Up to the time of his unfortunate death—he was murdered on his verandah by a fanatical Moplah—he controlled their management and laid the foundations for what is now, acre for acre, one of the most valuable forest properties in the world.

Descriptions of Illustrations

Plate 11 shows a portion of the Nilambur teak plantation which is now preserved in memory of Mr. H. V. Conolly, Collector of Malabar. The size of the trees can be judged from the figure at the base.—(Photo taken by H. G. Champion, I.F.S., January 1934.)

Plate 12. This photograph was taken by Mr. H. P. W. Davis, I.F.S., during a recent visit to those plantations. The figure standing

beside the memorial is that of Mr. A. K. Kandan, R.F.O., Nilambur. The memorial, which stands in a portion of the original plantation of 1846 (preserved as a model), is inscribed on one side in Malayan and on the other in English as follows:

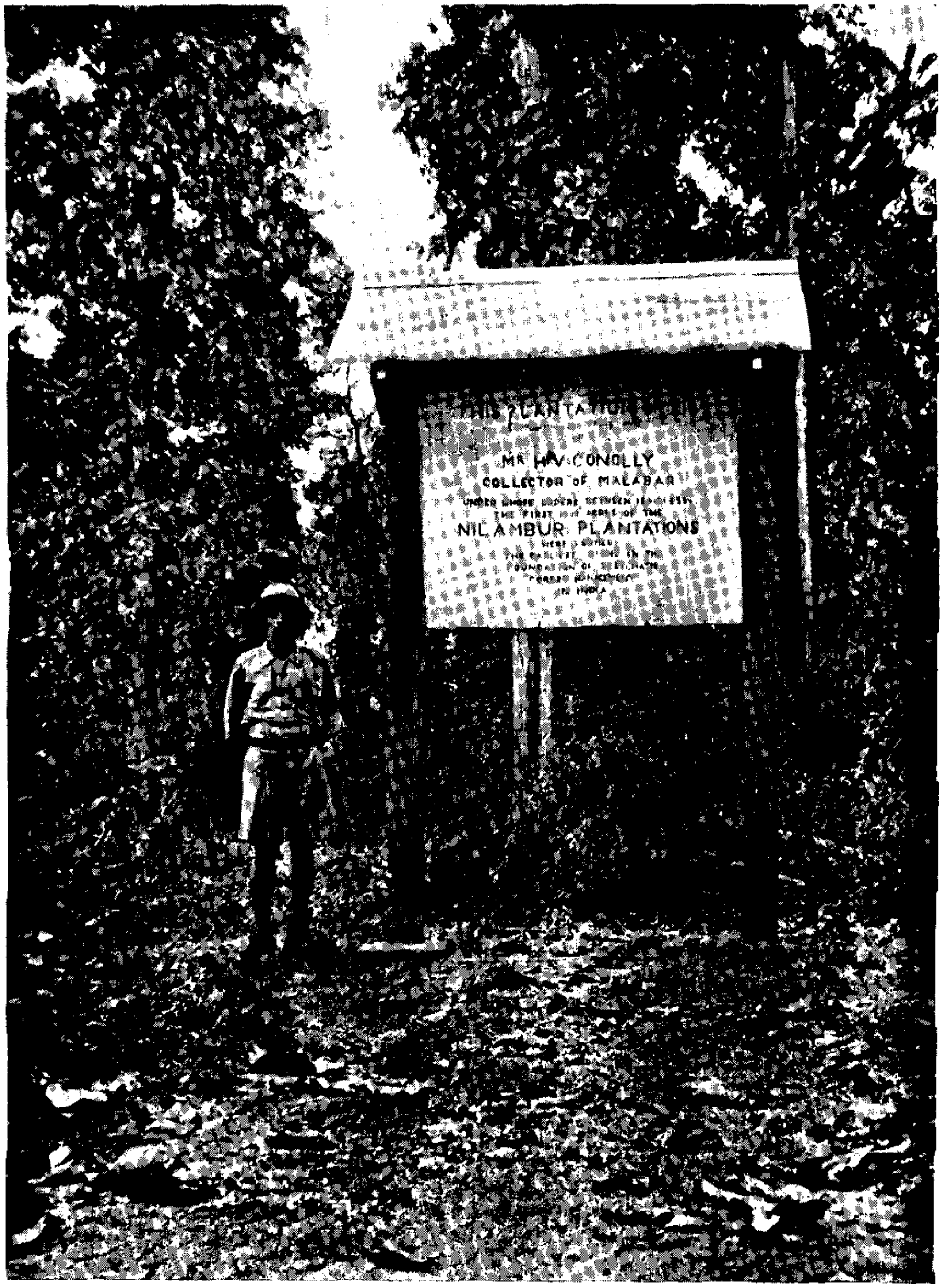
"This plantation of 1846
commemorates the work
of
Mr. H. V. Conolly,
Collector of Malabar,
under whose orders between 1846 and 1865
the first 1,500 acres of the Nilambur plantations
were formed.
The earliest stone in the foundation of systematic forest
management in India."

THE FORESTRY COURT

U. P. Agricultural and Industrial Exhibition, Lucknow, December 5th, 1936 to February 24th, 1937.

BY D. STEWART, I.F.S.

When the Government of the United Provinces had decided to lend its aid to a large Agricultural and Industrial Exhibition to be held in Lucknow during the cold weather of 1936-37, invitations were issued inviting the various Government departments of the United Provinces to participate. Unfortunately, owing to financial stringency, Government was not in a position to make special grants to departments for this purpose and departments were informed that the expense of participating in the Exhibition would have to be met from savings in their current year's budget. Not only so, but the amount which most Government departments, other than the Department of Agriculture, was allowed to spend was limited by Government to Rs. 15,000 or Rs. 20,000. Compared with the big Allahabad Exhibition of 1911 this rather restricted the activities of the U. P. Forest Department which was informed by Government that it should


MR H.V. CONOLLY
COLLECTOR OF MALABAR
NILAMBUR PLANTATIONS

limit its participation in the Exhibition mainly to items which were likely to stimulate the trading side of the department and to prove financially remunerative in the not-too-distant future. At the same time the Government of the United Provinces expressed the hope that the Government of India, through the Forest Research Institute, Dehra Dun, would be able to assist the U. P. Forest Department both financially and materially in the Exhibition. Fortunately the Forest Research Institute at Dehra Dun was ultimately able to do so, and I think it can be claimed that the Forestry Court, which has been erected at the Lucknow Exhibition as a result of the joint efforts of the Forest Research Institute and the U. P. Forest Department, is not unworthy of the occasion and has gained considerable credit and publicity for forest work and research.

The accompanying photographs and plan will give an idea of the scope and layout of the Forestry Court. It consists of—

(1) A model earthquake-proof, storm-proof, white-ant-proof, borer-proof and fungus-proof wooden house built entirely of ASCU treated chir pine timber. Two rooms downstairs are furnished with furniture made at the Forest Research Institute, Dehra Dun. One of these rooms is panelled in *sissoo* plywood made at the Forest Research Institute and furnished with high-class furniture. The other room is got up as a green bedroom with furniture of a cheaper variety also made at the Forest Research Institute. The third room downstairs is devoted to exhibits of general interest from the Forest Research Institute. There is also a small enquiry room and an ASCU stall under the charge of Messrs. Callenders Cable & Construction Co., Ltd. The two rooms upstairs are reserved as offices and are not furnished.

The interior painting of the house has been done free as an advertisement by Messrs. Robert Ingham Clark, of Calcutta, and the exterior painting has been done similarly by Messrs. Shalimar, Calcutta. The window curtains and the bed covering in the bedroom have been done free by Messrs. Trevillion and Clark, Lucknow, and the carpets in the two furnished rooms have been very kindly lent by

Messrs. E. Hill & Co., Ltd., Mirzapur. The entire electric wiring of the house has been done free by Messrs. Callenders Cable & Construction Co., Ltd., who have also supplied electric radiators.

(2) Behind the house is an ASCU treating plant supplied and operated by Messrs. Callenders Cable & Construction Co., Ltd. The plant is 30 feet long and has an extra cylinder for extending it to 40 feet.

(3) On the southern side of the house is an air-seasoning timber exhibit arranged by the Forest Research Institute, together with coloured posters in English, Urdu and Hindi explaining how air seasoning of sawn timber should be done.

(4) On one of the main roads outside the Forestry Court and across a deep nala near the main entrance to the Exhibition grounds is a heavy traffic bridge made entirely of sal timber treated with ASCU and capable of taking a uniformly distributed load of 35 tons. The heavy traffic bridge has a clear span of 48 feet and is 16 feet wide. The bridge was fabricated at the Forest Research Institute from sal timber supplied free by the U. P. Forest Department. It is intended to illustrate the suitability of treated timber for highway bridges of large span and heavy load carrying capacity.

(5) Across the pond in the Forestry Court is an artistic wooden footbridge 9 feet wide and with a clear span of 22 feet.

(6) A demonstration of *katha*-making is given by a U. P. forest contractor. Both the indigenous country method and the improved Forest Research Institute country method is demonstrated.

(7) In front of the house, and adding a very artistic finish to the whole Court, is a semi-circular pond with elaborately laid out gardens.

(8) On the edge of the pond is a Wild Life Pavilion organised by the U. P. Association for the Preservation of Game, with valuable trophies, including the world record sambhur and chital heads, and many fine wild life photographs.

(9) To the north of the pond and merging into the Woodcraft

GENERAL VIEW OF THE FORESTRY COURT, LUCKNOW EXHIBITION

Left to right

1. WILD LIFE PAVILION
2. FOOTBRIDGE
3. DEMONSTRATION TIMBER HOUSE
4. EROSION MODEL
5. EXHIBITION AND LECTURE ROOM

DEMONSTRATION ASCU TREATED TIMBER HOUSE *AND PART OF THE* DEMONSTRATION FOOT-BRIDGE WITH POND AND GARDENS

THE EROSION MODEL

VIEW OF THE INTERIOR

THE EROSION MODEL

THE MODEL IS HOUSED IN AN OPEN SUMMER HOUSE WHICH MAKES IT EASY FOR THE PUBLIC TO SEE

DEMONSTRATION TIMBER HOUSE.

INTERIOR VIEW OF PANELLED ROOM

DEMONSTRATION WOODEN HOUSE

INTERIOR VIEW OF GREEN BEDROOM

Section of the Exhibition is a combined lecture room and Exhibition room 50′ × 25′. It contains—

(a) Various forest exhibits from the U. P. forests, and forest photographs, partly from the U. P. and partly from the Forest Research Institute, including many enlargements of silvicultural interest finely coloured by the Silviculturist's Branch at the Forest Research Institute.

(b) Exhibits lent by the Western India Match Co., Ltd., the Indian Wood Products Co., Ltd., the Central Wood Working Institute, Bareilly, and the Indian Turpentine & Rosin Co., Clutterbuckganj. The exhibits of these companies consist of the following:

(1) *The Western India Match Co., Ltd., Clutterbuckganj, Bareilly*—
Several show-cases illustrating the various processes in the manufacture of matches, from the raw log to the finished match.

(2) *The Indian Wood-Products Co., Ltd., Izatnagar, Bareilly*—
One show-case illustrating the high quality *katha* and *kutch* manufactured from *khair* (*Acacia catechu*) trees by this Company.

(3) *The Indian Turpentine & Rosin Co., Ltd., Clutterbuckganj, Bareilly*—
Show-cases illustrating—

(a) Turpentine, rosin and other products of the turpentine factory.

(b) Different kinds of bobbins, tool handles, etc., made in the bobbin factory.

(c) Packing cases, wooden casks, etc., made at the Company's sawmill and factory.

(10) Adjoining the lecture room and Exhibition room is a combined rest room and reading room 25′ × 25′ in which a large collection of literature on forests is displayed and where visitors to the Forestry Court can rest and peruse forestry publications. This room also contains a series of panels on which are displayed the entire U. P. Forest Department collection of photographs and many finely coloured enlargements done by the Silviculturist's Branch of the Forest Research Institute.

(11) Near the Wild Life Pavilion is a typical Tharu hut in which a family belonging to this forest tribe of the Tarai lives and gives demonstrations of coloured basket-making and mat-making from jungle grasses.

(12) Last, but by no means least, comes the elaborate Erosion model which is artistically situated in a pretty little summer house in the angle between the reading room and the combined lecture and Exhibition room. The model is a replica, with minor modifications, of the Erosion Model in the Silviculturist's museum in the Forest Research Institute. It is 12′ × 8′ × 9′ high showing hilly country half covered with forest and half uncovered. There is a permanent clear stream flowing through the forest half, and a stream starting off but soon disappearing in the dry stony *nala* bed of the unforested area. There is a spray arrangement for producing artificial rain and many times a day the monsoon is turned on to demonstrate its destructive erosive effects on the bare hillsides, and the beneficial effects of forests in preventing soil erosion, conserving soil moisture and regulating the water-supply in streams. The following is the inscription printed boldly in English, Urdu and Hindi on the Model for all to read:

Forests save our fields. Rain water is held up by the trees and absorbed by the litter and the more porous forest soil, thus preventing floods and erosion and regulating and prolonging the flow of water in the streams. Villages in forested valleys are prosperous, having good soil, and good, regular water-supply, no danger from floods, and a source of timber for house-building, wood for fuel and grazing for cattle.

No forests no fields. Where forests have been gradually destroyed by overfelling and goat and cattle browsing, there is no protection to the soil. Sudden disastrous floods occur accompanied by erosion and landslips. Surface soil is washed away and carried down in muddy torrents. What was a prosperous valley is now a desert. The village has had to be abandoned as there is now no regular supply of water, the good soil on the fields has been washed away and only infertile subsoil left. There is now no timber and no grazing.

This Erosion Model has proved itself of enormous popular interest and large crowds are attracted to it daily. It is only necessary to stand and listen to the remarks of the onlookers to realise that not only is the artistic Model with its falling monsoon, rushing torrents, and incipient landslips a popular spectacle, but that it is of very great educative value and is a most excellent means of impressing on the public what the protective value of forests in the hills really is. In any Province where the preservation of hill forests for protective reasons is a prime necessity, I strongly recommend the instalation of a similar model either at an Exhibition or any other place or occasion where it is possible for the public to view it in large numbers. I can think of no better method of educating public opinion.

The demonstration ASCU-treated timber house has aroused great popular interest at the Exhibition and has undoubtedly stimulated interest in the construction of houses made entirely of timber. There have been numerous enquiries from landowners and others and it is practically certain that, as a result of this exhibit, many people will go in for all timber houses. The house is not supposed to be a model house. It is merely a demonstration of what can be done with timber and the design can be modified in any way necessary to suit individual tastes and local necessities. The principal features which have attracted attention are its cheapness, its earthquake-resisting capabilities, its mass production possibilities and the ease with which it can be assembled or dissembled.

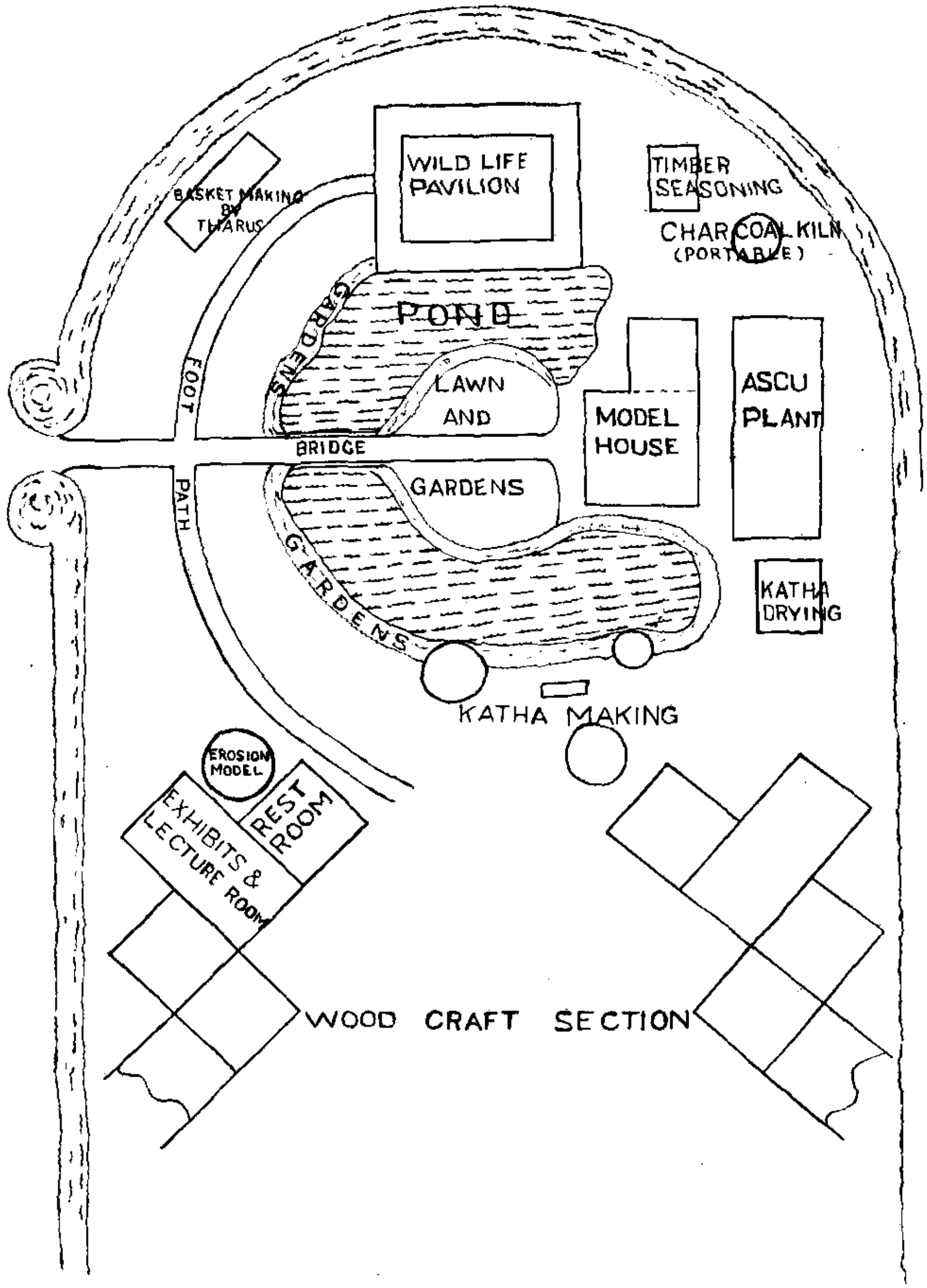
Inside the house the excellent furniture produced by the Forest Research Institute, both from superior and inferior timbers, has been much admired. The idea behind the furniture exhibits is to stimulate the Indian furniture firms to better efforts by showing them what really high-class furniture can be made from Indian timbers. This object has, I think, to a considerable extent been realised. The general public has been much attracted by this furniture and this will automatically result in a higher quality being demanded from Indian furniture manufacturers. The Government Central Woodworking Institute, Bareilly, has undertaken to make duplicates of the Forest Research Institute furniture displayed at the Exhibition and some orders have already been placed.

One room inside the wooden house is panelled with 3-ply sissoo made at the Forest Research Institute. This 3-ply sissoo panelling has been greatly admired and has stimulated public interest in the matter of getting a real Indian plywood industry started for making plywood, both decorative and plain, from Indian timbers. The consumption of plywood in India is enormous, but at present it is nearly all imported, mostly from Japan. For doing the ordinary plain panelling of our wooden house we found that we had to use Japanese plywood as no plywood, apart from some plywood for tea boxes, is manufactured in India on a commercial scale. There is a great opening here for Indian capital and enterprise and we are bringing this forcibly to the notice of the public at the Lucknow Exhibition by means of posters and notices.

Propaganda by means of coloured posters, leaflets and photographs forms an important part of our activities at the Exhibition. The Forest Research Institute has recently produced a considerable series of excellent posters which we are displaying and some of these have been specially printed in Urdu and Hindi by the U. P. Forest Department. We have had several thousand leaflets printed for free distribution giving all necessary details and photographs of (1) the demonstration timber house, (2) the heavy traffic highway bridge, (3) the footbridge, and we shall be glad to supply copies free to any readers of the *Indian Forester* who are interested.

Considering the extent of our exhibits, and the fact that the Forestry Court is generally acknowledged to be one of the most attractive and instructive Courts in the Lucknow Exhibition, the cost incurred has not been large. Final figures are not yet available, but, so far as we can estimate at the moment, the U. P. Forest Department will have spent about Rs. 10,000 and the Forest Research Institute about Rs. 8,000. This is direct expenditure and does not include expenditure on staff. Practically all the staff employed consists of Forest Officers and subordinates specially deputed to Exhibition duty, and, apart from a few temporary chaprassies and one clerk, no special staff has been employed. The extra cost with regard to staff is, therefore, very small.

FORESTRY COURT
LUCKNOW EXHIBITION



FOREST WEALTH OF INDIA

By K. K. Sarkar, B.A., Record Clerk, Economic Branch,

F. R. I.

Summary—India is a vast country having an area of about 1,099,313 square miles, of which nearly 261,219 square miles are under forests, giving an outturn of 1,201 c. ft. of timber and fuel and Rs. 42 of minor products per square mile in 1932-33. Much has been of late done by research and active propaganda to find use and market for this huge quantity and to make it stand foreign competition. Thus the import trade is declining markedly year by year. But few individuals can possibly afford to invest in forests a form of capital which requires long and patient waiting, careful and well-chalked-out working plans and strict adherence to same, a dragon-like watchfulness against forest fires, indiscreet or over-cutting of the immature standing crops and the commission of forest offences, and, as they are so intimately bound to our best interests, *viz., national prosperity and safety, they may, with advantage, remain under the management of the Central Government.*

The term "Forest wealth of India" signifies much more than is likely to be understood at first sight, and to have an average idea of what it is worth at its present semi-developed stage, it is necessary to step aside and see what it was worth, say, a hundred years ago.

2. No one of India in those days probably even thought that the huge virgin forests ever rendered any service other than supplying his house posts or fuel. They were, he surely thought, a positive nuisance, harbouring the *thug*, the bandit, the bad character and the offensive wild animals whose activities are always at war with the interests of an honest man, and he unhesitatingly recorded in his Book of Good Counsels that a jungle is never to be trusted like other untrustworthy factors, *viz.* (1) a watery expanse, (2) a dark night, (3) an ox, (4) and an unknown people.

3. He did not realise how woodland influenced the climate, the rainfall, soil, crops, epidemics, land erosions, famines, etc. He did not know what these forests were comprised of, or if it were possible to get out of them more than the generous estimate he made when standing on the top of the lofty Kutb Minar and viewing the countryside, "This Heart's Eye (Delhi), Huzur," he declared, "is decked with long lashes of standing trees sufficient to be used as fuel for eight Akhouninis of army."

4. But India is a vast country having an area of about 1,099,313 square miles, of which nearly 261,219 square miles are under forests,

giving an outturn of 1,201 c.ft. of timber and fuel and Rs. 42 of minor products per square mile in 1932-33. The present administration did not valuate them so quickly and in terms of fire-wood, but considered that to unravel this forest wealth, to manage it efficiently and to use it to best advantage required the services of men who are naturally bold, intelligent, resourceful, lovers of the wild and admirers of both fine and gross aspects of nature. These men constitute the Forest Department of India.

5. They told us some decades back that India possessed about 2,000 species of trees by way of major products and bamboos, fire-wood, grass, lac, elephant tusks, rhino horns, bees-wax, silk, cane, gums, resins, oleo-resins, myrabolams, sandalwood, and herbs of medicinal property by way of minor products, out of which any revenue could be derived, which was somewhere at Rs. 50,30,061 in the year 1873-74.

6. To put a stop there would be woefully to belittle their potentiality, and this being evident it was found necessary that over and above the existing staff engaged in the care and management of the forests there must be another set of scientific people who should be equipped with workshops, factories, and laboratories and who should devote their whole time and attention in searching out ways and means to utilise the forest products to the best and to the most and to educate the public in this direction. Thus came the Forest Research Institute into existence, and about this time (1909) we find the revenue to have gone up by more than five times of what it was in 1873-74 to Rs. 2,60,25,794, and after meeting the cost the Forest Department showed a handsome surplus of 1,11,05,140 rupees.

7. But even at this time we do not hear of any considerable export trade in Indian timbers or in many minor products except only a few like teak, sandalwood, myrabolams, gum acacia, lac, resins, and a few medicinal herbs. On the other hand huge quantities of railway sleepers of deal and jarrah wood used to be imported into India from abroad until very recently when it was definitely proved by the Forest Research Institute that indigenous timbers are particularly suited for service under the climatic conditions they grow in,

while preservatives and the newer methods of artificial and air seasoning have endowed them with a longer life and a better service capacity. As a result of this imports are declining every year to the advantage of the indigenous lumber industry.

8. Under the searchlight of this Institute better and surer means of regeneration and protection of forests are being found, their diseases and enemies are being located, identified and dealt with; while laboratory tests are suggesting new and probable uses of both major and minor products. The labours of the Drugs Enquiry Committee collaborated by this Institute has immensely helped the small and obscure herbs to come into the limelight, so much so that Kashmere is now deriving a nett revenue of lacs every year out of a few drugs which are now being cultivated there.

9. In 1932-33 the share of minor products in revenue was 110·66 lacs—bamboo contributing 16·29 lacs, grazing and fodder 63·62 lacs and miscellaneous products 30·75 lacs. Extensive and justly merited propaganda done through the agency of the publications of this Institute, the Empire Marketing Board, the Forest Products Laboratory, the Timber Advisory Officer to the High Commissioner, the Trade Commissioner at Hamburg, the Timber Trades Development Association and others has brought the lesser known products to the forefront, and has immensely helped to find market and good prices for them. Thus we find that Indian timbers are gradually finding market in the United Kingdom and the Continental countries. Although Australian sandalwood has of late been a serious competitor to the genuine sandalwood and sandalwood oil of India, still China, Japan, U. S. A., United Kingdom prefer those of Indian origin at such a price as Rs. 1,500 per ton of sandalwood, or Rs. 2 an ounce of distilled sandalwood oil.

10. As to India's internal consumption, the uninitiated public might be curious to know how the huge quantities of these products are used. The Railway Workshops absorb considerable quantities of teak, laurel, silver grey, padauk, sissoo, gurjan, sal, etc., for building carriage and coaches, cross-ties, etc., the Gun and Rifle Factories use walnut for making gunstocks; the Gun Carriage Factories use

sissoo and babul for making gun-carriage wheels; boat and ship-building industries use principally teak, sal and sundri; the match industry uses semul; pencil and penholder industries use cedar, toon, etc., the pulp and paper industry uses bamboos, cotton-seed, grasses, and bagasse in addition to the customary raw materials; boxwood is used for making drawing instruments; toon, neem and khair go to make musical instruments; ash, mulberry, chooi, chuglam, etc., go to make sporting requisites and fishing rods. Teak, chir, kail, toon and sain go for ordinary furniture. Commoner timbers are used for making packing cases, tea chests, pit-props, etc.; haldu and gmelina give good tool handles and yon makes good oilwell sucker rods, while huge quantities of myrabolams are used for making medicines and tans; essential oils are derived from the seeds, stems, barks and leaves of various wild herbs and trees and grasses; *Bassia latifolia* yields alcohol on distillation of its flowers; cutch and *katha* are prepared by boiling chips of mature heartwood of the khair tree, while the tendu leaf pipe (*bidi*) is a welcome companion of the modest Indian. Besides these there are hundreds of other uses to which these forest products are put.

11. But in spite of this tempting outturn, few individuals can afford to invest in a form of capital which requires long and patient waiting, careful and well-chalked-out working plans and strict adherence to same, and a dragon watchfulness against the commission of forest offences, forest fires and indiscreet or over-cutting of the immature standing crops. As such the forests should always remain under the Central State management, to yield a sustained and substantial revenue and to be a blessing to the nation.

12. The master-minds that realised these facts and directed their whole heart and soul towards this end, are the great pillars of the Forest Department. Brandis, Pearson, Baden-Powell, Schlich, Ribbentrop, Hill, Wroughton, Eardley-Wilmot, Lace, Bryant, Mercer, Hart, Clutterbuck, Rodger and Troup are names saintly not to Foresters only but to mankind and the F. R. I. Convocation Hall pillars in bearing them on head in characters of gold will continue to offer homage to the Indian Forest Service.

13. We must admit here that we should be guilty of ungratefulness to them who have pointed out to us what a wealth these masses of living waste contain and how inseparably they are bound to our best interests and well-being, should we fail to thank them for all this and for the sacrifice they made when leaving happy home and hearth behind, they went out on risky excursions for exploration of newer areas and collection of newer and rarer specimens. Nay, let us say, "May the Almighty ever bless them in Activity and at Rest."

[As far as we know, no clerk has ever written anything for the *Indian Forester*. This essay is rather a good effort on the part of a clerk and we are very glad to publish it. We have not tried to edit it otherwise half the value of the effort would be lost. We hope that *others would also follow the example of the author.—Hon. Ed.*]

REVIEWS

ANDAMANS FOREST ADMINISTRATION REPORT, 1935-36

Working Plan.—The most important feature of the year's work has been the completion of the Working Plan for all the forests of the Andamans. This plan was finally sanctioned by the Government of India in their letter No. F.56-3-/35-F., dated the 8th January 1936, and was brought into force with effect from the 1st April 1936. The plan includes, in addition to a complete exploitation scheme for the next ten years, detailed silvicultural prescriptions for the natural regeneration of a minimum of one square mile per annum. This has been rendered possible by the silvicultural research which has been carried out during the past five years, as a result of which it is now possible to regenerate all the important species of the Andamans at a reasonable cost. The credit for this advance in silvicultural knowledge is very largely due to Mr. Chengappa, Extra Assistant Conservator of Forests, whose services I have great pleasure in commending to the Government of India.

Experiments on reduction in the cost of natural regeneration are still in progress.

Exploitation.—The volume extracted remained approximately the same as last year, *viz.* 38,142 tons against 38,292 tons. There has been a reduction in the cost of extraction in logs from 17·8 to 16·8 rupees per ton. The rate for milling squares and scantlings has also been reduced from Rs. 39·7 to 34·8 and Rs. 64·6 to 56·7 per ton respectively. These reductions are responsible for the better financial results displayed this year. In particular the sawing of scantlings show a profit of Rs. 35,869 as compared to a loss of Rs. 47,722 last year. There has been much correspondence regarding this loss in scantlings and it is exceedingly satisfactory that these losses have now been entirely eliminated. Although this business still does not show a direct profit in Calcutta, sales of scantlings on the whole are remunerative and it is hoped Calcutta prices will improve. Unless, however, better prices are forthcoming in this market it should be

our policy to develop markets in London, Madras and possibly Bombay, and increase our sales there at the expense of Calcutta.

The following statement compares the sales of timber in the various markets with the figures of the previous year:

	1934-35.				1935-36.			
	Logs.	Squares.	Scantlings.	Total.	Logs.	Squares.	Scantlings.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Calcutta ..	1,09,920	1,72,540	3,13,132	5,95,592	1,78,871	1,58,095	2,71,439	6,08,405
Madras ..	8,106	64	1,60,268	1,68,438	80,725	..	2,14,355	2,95,080
Rangoon ..	2,04,652	..	..	2,04,652	1,20,917	..	..	1,20,917
London ..	22	56,824	1,03,315	1,60,161	818	29,120	1,16,395	1,46,333
Bombay ..	14,138	43,995	..	58,133	78,059	22,162	..	1,00,221
Other markets..	..	1,719	..	1,719	..	1,072	..	1,072
Local ..	1,560	791	37,889	40,240	3,989	95	47,835	51,919
Total ..	3,38,398	2,75,933	6,14,604	12,28,935	4,63,379	2,10,544	6,50,024	13,23,947

The net financial results of trading in the various markets are summarised below and compared with those of the previous year.

	1934-35			1935-36		
	Logs.	Squares.	Scantlings.	Logs.	Squares.	Scantlings.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Calcutta ..	26,448	61,010	—80,186	36,920	49,337	—38,888
Madras ..	2,151	37	—6,290	19,619	..	27,125
Rangoon ..	44,222	..	..	29,124	..	..
London ..	—15	23,087	27,228	279	12,827	29,565
Bombay ..	4,551	24,362	..	28,713	14,295	..
Other markets ..	..	702	..	..	437	..
Local ..	693	633	11,526	1,846	72	18,067
Total ..	78,050	1,09,831	—47,722	1,16,501	76,968	35,869

The financial results per species of timber are further given in the following table from which it will be seen that the profits on working gurjan still leave a margin for considerable improvement.

Total turnover in terms of logs.	Species.	Logs.	Squares.	Scantlings.	Total.	Profit per ton of logs.
Tons.		Rs.	Rs.	Rs.	Rs.	Rs.
12,168	Gurjan ..	259	512	15,794	16,565	1·36
6,812	Padauk ..	262	62,769	35,453	98,484	14·45
2,322	White Chuglam ..	263	12,823	9,841	22,927	9·87
8,761	White Dhup ..	53,634	—6	—9,460	44,168	5·04
4,922	Papita ..	37,459	..	..	37,459	7·61
3,255	Others ..	9,982	731	—5,164	5,549	1·70
38,240	Total ..	1,01,859	76,829	46,464	2,25,152	5·88

Financial Results.—The revenue realised during the year amounted to Rs. 14,94,845 and the expenditure Rs. 9,87,009, leaving a cash surplus of Rs. 5,07,836 in the Treasury. The balance sheet for the year shows a profit of Rs. 56,977 against a loss of Rs. 39,464 last year. This profit results after making the following adjustments :

	Rs.
Interest on capital	1,12,221
Depreciation of assets	1,31,976
Leave and pension contributions	25,861
Audit fees	6,000
	2,76,058

In a joint stock company the amount available for a dividend would be the profit of Rs. 56,977 plus the interest of Rs. 1,12,221 or a total of Rs. 1,69,198 which represents 8·06 per cent. on the average capital invested in the concern as compared with 3·31 per cent., last year's figure. In this connection I would refer to the remarks in para. 15 of my inspection note of February 1936 regarding

interest on unproductive capital. In an ordinary commercial undertaking steps would have to be taken to write off such lost capital. Many firms have had to do this during the depression before they could pay any dividends on their share capital.

General Administration.—Mr. Flewett held the post of Chief Forest Officer until the 28th October 1935 when he proceeded on leave on medical advice and was succeeded by Mr. Foster who remains in charge. Mr. Flewett has rendered very great services to Government in the administration of the forests of the Andamans. He has effected great economies in the cost of exploitation and has improved the technical efficiency of the saw milling industry. He only vacated the appointment of Chief Forest Officer on grounds of ill health and he deserves the greatest credit for his work during the four years he has been in the Andamans.

The Inspector-General of Forests toured in the Andamans in February 1936 and went into full details regarding the finances and the administration of this concern. Orders are still awaited on certain of the recommendations of his inspection note.

C. G. T.

REPORT OF FOREST ADMINISTRATION IN ASSAM FOR THE YEAR 1935-36

The most gratifying feature of the working of the year 1935-36 was the increased surplus amounting to Rs. 3,55,725 as against Rs. 2,57,506 in the preceding year. The average surplus of the five years from 1930-31 to 1934-35 was Rs. 2,37,175. To judge from the figures available for the current year there is every expectation that this welcome improvement will continue. The main reason for the increase is a betterment in general trade conditions and the efforts made to secure fresh outlets for forest produce. The creation of the post of Forest Utilisation Officer early in the year has amply justified itself. Expenditure was almost half a lakh less than the preceding year and about 3¾ lakhs less than in the quinquennium 1930-31 to 1934-35. It is recognised, however, that continued financial improvement can only be secured by a reasonable expenditure on the

proper maintenance of the Forest Reserves, including the entertainment of an adequate subordinate staff. Since the close of the year steps have been taken to fill up posts which have in recent years, for reasons of economy, been kept vacant.

The efforts of the Public Health Department to combat disease in unhealthy areas in the Goalpara forests met with encouraging results. The general health of the forest staff throughout the province was fair.

New draft rules for regulating sport in reserved forests have recently been drawn up in order to bring *shikar* under control by limiting the bag, prescribing periods of rest for shooting blocks, and prohibiting doubtful methods of shikar. It is proposed to constitute two reserves for the preservation of wild buffalo.

From the *kheddah*, in the Sibsagar district, there was a net profit of Rs. 33,903. From captures in other districts the royalty amounted to Rs. 18,250. The increase in the number of the bigger elephants roaming throughout the province constitutes a serious problem owing to the destruction of crops. There was no market for such large elephants and relief could only be given to the cultivator by shooting them. The policy of granting free licences for this purpose had met with some success.

The Conservator of Forests points out that as the result of the practice of shifting cultivation there have been constant floods in the plains and warns that unless steps are taken to prevent them part of Assam will become a mere waste land.

The visit of Mr. C. G. Trevor, C.I.E., Inspector-General of Forests, afforded an opportunity for an interchange of views on several current problems, particularly on the question of sal natural regeneration. It is encouraging to find that in his opinion this problem had been solved in the case of the sal forests in Kamrup district, thanks to the system of rains-weeding. The *Eupatorium* hitherto dreaded as a foe seems likely to prove a friend, as an excellent nurse for young sal. Though conditions vary in sal forests in different districts it is all to the good that sal natural regeneration has now been proved to be no longer a possibility but a reality.

It is sad to record that Mr. Milroy, the author of the report, has since died. It was mainly due to his enthusiasm and energy that the problem of natural regeneration of sal in Kamrup is well on the way to being solved. His death has been a great loss to Indian Forestry.

L. R. S.

THE LAND NOW AND TO-MORROW

BY R. G. STAPLEDON. (FABER AND FABER, 15s.)

This is a most stimulating and constructive book which should appeal to all foresters who are interested in the broader conceptions of land use, of which forestry forms such an important part. The author contends that it is the duty of the State to make the care of the land the core of their agricultural policy. To this end he advocates flexibility rather than a static outlook, so as to be ready to orientate the policy to meet changes, both economic and social, instead of waiting until they are thrust upon us. This is obviously simpler to do in ordinary agricultural practice than in forestry, but in these and other observations the author includes forestry in his interpretation of agriculture in its widest sense, namely the best utilisation of the land to meet its occupants' needs. In actual fact, Mr. Stapledon's outlook is more that of the average forester than of the farmer in so far as he prefers to look 50 or even 100 years ahead rather than one, and in doing so he tries to interpret what changes will be forced upon British land management by the growing demands of a vast army of town dwellers with a mind to use the country during their greatly increased periods of leisure. In this respect perhaps we have no parallel in India under the present economic conditions, though it is noticeable how many D. F. Os. devote time and energy to improving the touring facilities which will encourage the Indian public to visit their forests. In another respect there is a much closer parallel, and that is in the rapidly-growing demand for dairy produce, now that the scientific aspects of nutrition are becoming better appreciated in both countries.

To meet this demand for a more plentiful milk supply the natural vegetation is a natural resource which should be husbanded and

improved to the utmost, instead of being squandered through improvident use. Curiously enough, the worst misuse of pastures in Britain is under-stocking, while in India it is almost universal over-stocking. In both cases, however, there are almost unlimited possibilities for improving the quality and feeding value of pastures, and as the custodians of vast areas of grazing lands and of forests yielding cut-grass fodder, the Forest Service in India is vitally concerned with such developments.

The process of pasture improvement, which has been demonstrated by Mr. Stapledon of the Welsh Plant Breeding Station and by other pioneer farmers in Wales and Scotland, consists chiefly in "roughing up" the moor or grassland with a heavy plough or scarifier, followed by the sowing of clover or manuring with phosphates. Manuring is not usually essential, because the clover by itself has much the same effect as a manure, in that it encourages the better local grasses to come in wherever it becomes established. The well-known faculty of clover and other legumes for manufacturing their own nitrogen and storing it in the soil is apparently responsible for this development. Following this improvement, or in order to hasten it, the sowing of improved strains of pasture grasses is being increasingly done, now that the plant-breeding agencies are producing such seed in larger quantities and at reasonable prices.

The cash returns from such reclamation work are considerable and the indirect rewards in better-fed livestock and in the improved carrying capacity of the land should serve to give a fresh outlook for the hill farmers of Britain, whose land has been steadily retrograding with the invasion of bracken fern, rushes and the poorest grasses. Similar projects have been outlined for certain of the Punjab districts for which counter-erosion and land improvement schemes have recently been prepared, but a technique in grassland improvement has yet to be worked out for each major climatic and botanic unit of area. We want to know just how far the role of clover as a pasture improver as proved in Australia and Britain can be made use of under Indian conditions, and, failing this, what local leguminous plants can be made to serve this purpose.

Mr. Stapledon quotes many striking figures showing the changes —mostly for the worse—which have taken place in Britain. Between 1866 and 1932 arable acreage has decreased by 36 per cent. from $14\frac{1}{2}$ to less than $9\frac{1}{2}$ million acres, while permanent grassland has increased 39 per cent. from 11 to nearly 16 million, much of which is now overrun with bracken, docken and the poorest possible kinds of grasses. In India on the other hand the area of grazing land has almost certainly been reduced by extensions of cultivation so there is all the greater need for the husbanding of what is left by closer attention to grazing rotation, stall-feeding and active improvements on the lines which Mr. Stapledon and other grassland pioneers are now demonstrating in Britain. Equally in both countries it is management or mismanagement that has made the grasslands what they are, and an active policy of improvement holds immense possibilities which the Forest Department, as the warden of much of India's wild grazing lands, must not remain blind to.

The author's criticism of the British Forestry Commission is interesting: "I have endeavoured to show that in so far as afforestation and land improvement are concerned they must both be regarded as parts of the same problem, while æsthetics are always inseparable from all matters appertaining to the land. It is unfortunate, therefore, that when in 1919 the Forestry Commission was set up it was only the timber *qua* timber aspect of afforestation that was considered. It would probably now be difficult, though perhaps not impracticable, to widen the base of the Forestry Commission and to extend its terms of reference to that of land improvement, land reclamation and rural beautification in all their bearings (including, of course, afforestation) and to support such a widened term of reference by increased powers relative to the acquisition of land and by increased financial resources. The very success of the endeavours of the Forestry Commission in a too narrow field only tends to emphasize the urgent need of the closest possible co-ordination between all the interests concerned in everything to do with land reclamation and land utilization."

The author criticises the absence in Britain of any final authority to govern the proper use of land. Land utilization and the land itself are not the supreme care of any one State department. "It is inconceivable that any country that had even the most rudimentary thought for posterity would permit itself to go floundering along with no State department keeping a firm hand and eagle eye on its most precious asset, and one that is most easily squandered or abused." The same criticism can be applied with equal force in India, where the State departments of Revenue, Irrigation, Public Works, Forestry, Agriculture and Veterinary are so often working each in their own groove without any attempt at co-operation for the wider good of the countryside as a whole.

The author's views on research are peculiarly apt and might well be adopted as a text by many research workers in Indian forestry and agriculture. "In so far as agricultural research is concerned, I am convinced that a serious mistake has been made in the endeavour to organize such research in terms of subjects—chemistry, physiology, genetics, economics—rather than in terms of the basal problems of agriculture itself. The problem is everything and is real, the subject, as I have said, is nothing but the product of a man-made classification. A particular problem may be claimed as the prerogative of either the chemist, the botanist, or even the veterinarian, and in the scramble for such a problem there is much scope for an unedifying display of professional snobbishness. In cold fact there are very few problems in agriculture the solution of which lies in the power of any one narrow specialist . . . . The tendency to-day is still to staff and administer even applied research on the basis of the sciences and subjects rather than on the basis of problems. A tendency which demonstrably exaggerates narrow specialization and encourages a search for lesser problems at which to work—problems of a type which the specialist in his arrogance may hope to solve by recourse only to the resources of his own science—rather than endeavours to unravel the problems which, from the practical and applied point of view, cry most loudly for solution."

R. M. G.

THE INTERNATIONAL CIRCULATION OF FORESTRY INFORMATION

We have recently received the second volume of the *Zeitschrift für Weltforstwirtschaft* (Review of World's Forestry) which is issued by Professor Heske of the Forest College at Tharandt, Saxony. It covers 1934-35 and runs to over 750 pages of which a considerable proportion is devoted to a review of forest literature of all countries.

There are ten original papers covering different aspects of forestry in Europe, generally in Russia, Germany, Austria, the United States of America and Canada, and English summaries are given of most. It cannot perhaps be said that any of these are of direct importance to Indian forestry though some are of interest to us such as forest fire insurance, methods of fauna preservation, etc.

In the notices, reviews and abstracts, there is not that preponderance of German material which critics have come to expect, in fact in the "Contents" Germany gets only four lines out of two full pages. At the same time, almost the whole letter-press is in German. Most of the reviewing, etc., has been done by the staff of the Institute for foreign and colonial forestry founded by Dr. Heske and it covers many publications including newspapers, which are not accessible to most but which sometimes include useful information.

The chief thought roused by the sight of this volume is that the need for rationalising the publication, referencing and abstracting of forest literature, is becoming greater rather than less by the appearance of one organisation after another claiming to do the job. This Institute (Dehra Dun) at the moment is by request supplying abstracts of Indian forest literature to four such organisations among which the Saxon one is not included. We are all agreed that no one can now follow all the literature put out and that referencing and abstracting is essential for the circulation and advancement of knowledge. We are most of us finding, however, that what we are getting—and admittedly what we are contributing—is still far from what we want. And what we want, we can't really have unless we do it for ourselves, for it is a review or abstract from our own national point of view. Bibliographies with title only are not really of very

much help. The present reviewer feels that the task before the several organisations now overlapping in this field is to avoid present useless duplication and to devote the energy thus saved to producing promptly three or four line summaries just sufficient to enable the reader to grasp what the subject is—and how often are titles utterly misleading—and to decide for himself whether he wants to know more about it. Trilingual publication seems essential and possibly the English edition of these summaries would have to be in two parts dealt with by America and Britain respectively. I suggest that about five centres British, American, French (including Spain, Italy and Belgium), German (including Holland, Switzerland, and S. E. Europe) and Scandinavian should abstract the literature appropriately allotted to each; this would be done in the one local language only. Arrangements for Russian and Far Eastern literature would require to be fitted in by making additional centres or distribution among these five. Each centre should record its opinion as to which abstracts of original papers dealt with are of sufficient interest to be published in all three languages and send advance copies of the whole to the other centres. Efficient translators would have to be maintained by each collaborating organisation to translate the advance copies of abstracts of literature supplied by the other centres.

The practice of including a summary or abstract with original articles is fortunately spreading, though author's summaries would often require condensing and editing for issue as abstracts. Abstracting important papers not summarised by their authors is a time-consuming task especially if it has to be done in a foreign tongue and often holds up publication in a way the three-line abstract never need do. Finally the organisations should be prepared to give translations of any of the summarised publications, on application. Short papers up to a predetermined length should be translated free of charge to subscribers and longer papers for a reasonable fee.

The trouble for a research officer trying to keep up with foreign literature is that he is often absent for weeks or months on tour or on leave, and experience shows that once arrears accumulate it becomes almost impossible to catch up.

In the West, secretarial staff competent to deal with the work of perusal and correct filing is perhaps available. It is not so for the many other foresters scattered over the world. The method of giving the reference numbers on an internationally accepted classification is an excellent one, provided existing records are not already too voluminous to change over from a system already in use. Theoretically a concordance puts that right, but is neither so easy nor so satisfactory as it appears till one tries to make and use one—still, this is not an insuperable difficulty.

Mr. Eden and others have demonstrated the uselessness of placing any hope or reliance on international co-operation on political issues, but is it beyond scientific foresters to show that it can be done by them ? National forest bibliographies are now being issued for the first time but by title only : it should not be an impossible step to develop these to include the extra information suggested above.

H. G. C.

FIFTEEN SOUTH AFRICAN HIGH FOREST TIMBER TREES

BY L. CHALK, M.M. CHATTAWAY, J. BURTT DAVY, F. S. LAUGHTON AND M. H. SCOTT

This is the third part of the well-known series, " Forest Trees and Timbers of the British Empire," started under the editorship of Drs. Chalk and Burtt Davy of the Imperial Forestry Institute, Oxford. The high standard of the previous parts has been fully maintained in this part. Some information on sawing and seasoning and working qualities has also been added. Moreover, some changes in the anatomical description of the wood have been made. In the two previous numbers, cell dimensions were given in the anatomical description of the wood, but in this number, cells are merely described under the anatomical description and one has to look up the appendix for the exact figures for the cell dimensions. This change has got certain advantages over the old method but, at the same time, the time spent in looking up the appendix cannot be ignored. This is,

however, only a minor point. On the whole, the book contains some very useful information and will be of help to those who are interested in South African forest trees and timbers.

K. A. C.

BIRDS OF AN INDIAN GARDEN

BY T. BAINBRIDGE FLETCHER AND C. M. INGLIS, SECOND EDITION (THACKER SPINK & CO., LTD., CALCUTTA. PRICE RS. 12.)

Indian ornithology can be conveniently divided into four well-defined periods. The first period comprises the pioneer work of Hodgson, Jerdon and Blyth. The second period was marked by the labours of Hume (1872 to 1888). The third period started with the publication of the "Fauna of British India, Birds," by Blandford and Oates (1889). The fourth period began with the publication of Stuart-Baker's second edition of the "Fauna," the first volume of which appeared in 1922. This last period is characterised by an increasing popular interest in the wonderful avifauna of this country and the publication of many popular books, not too scientific or too technical, on the Indian birds. One of the remarkable publications during this period was "Birds of an Indian Garden," by Bainbridge Fletcher and Inglis, published in ten parts by Messrs. Thacker, Spink & Co., in 1924. This publication really consisted of articles originally published in the *Agricultural Journal of India* from 1919—1924 under the title of "Some Common Indian Birds." The original articles were very popular and were read with great interest but they were accessible only to the readers of the *Agricultural Journal*, and it was very enterprising of the publishers to republish them in book form. This publication with its beautiful illustrations did a lot to awaken interest in the study of Indian birds. The book under review is a second edition of this book.

In the second edition the text has been revised and in places brought up to date. While the first edition contained only 30 coloured plates, the edition under review contains 33. The new

plates consist of the pretty red-whiskered Bulbul, the charming Fly-catcher and the cheerful Honey-suckers. Instead of one chapter on "The Bengal Red-vented Bulbuls" we have two chapters in the second edition: one on "Some Bulbuls," and the other on "The Red-whiskered Bulbul." In these two chapters one gets all the information one needs about the genus Molpastes. Similarly the extra chapters on Fly-catchers and Honey-suckers are very interesting and up to date.

One notable feature in the second edition is the more consistent adoption of the trinomial system of nomenclature. The adoption of binomial names as headings and then giving the trinomial names when describing the races will avoid any confusion and will be appreciated by the beginners.

There are several birds that one would have liked to see included in the book, but, as Mr. Fletcher remarks, "There is an old English saw anent the difficulty of getting a quart into a pint pot and the same principle necessarily applies to a book of this nature." One can only wish that more information could have been given about that common bird, the Jungle-babbler.

The illustrations are on the whole good and always faithful, and will certainly help in the identification of birds described, but they are not always very artistic. Every one knows that there are not many bird-artists available and the reader has much to thank Mr. Inglis for in these nice illustrations.

The price of the book (Rs. 12) is rather high, but considering the limited demand in this country it could not have been possibly priced lower. No school library in this country should be without this excellent book which will go a long way to stimulate the love of nature-study among the younger generation. Visitors to this country will find the book very helpful in knowing something about its wonderful avifauna. Perhaps the publishers may find it possible later on to bring out a cheaper edition of the book at a price suited to the moderate purse of an average school and college student in this country.

S. A. V.

EXTRACTS

INDIAN TIMBERS

* CHAPTER IV.

In terms of thousands of loads (normally one load is 50 cubic feet) the imports into the United Kingdom of unmanufactured timber from all sources of supply during 1935 compare as follows with those of 1934 and the average imports of the five-year period 1926-30:

IN THOUSANDS OF LOADS

		Average of 5 years. 1926-30	1934	1935	Imports of 1934 compared with the average of 1926-30
Hardwoods (hewn and sawn)	..	731	739	775	+44
Softwoods (hewn and sawn)	..	5,477	6,702	5,921	+444
Other descriptions	..	3,567	3,910	3,750	+183
Total	..	9,775	11,351	10,446	+671

In addition to timber, 12½ million cubic feet of plywood were imported during 1935 as against 10 million cubic feet imported during 1934.

The above figures illustrate the large quantities of timber required for use in the United Kingdom in spite of the competition of substitutes.

The volume of hardwoods imported during 1935 has only been once exceeded, *viz.* in *1929, when 777,000 loads were imported.*

Imports of Indian timbers totalled 39,000 cubic tons in 1935 as against 30,500 cubic tons in 1934, and an average of 37,000 cubic tons for the five-year period 1926-30. The increase was entirely in teak. The quantity of Indian hard-woods, other than teak, imported during 1935 was 2,500 tons as against 2,600 tons in 1934, and an average of 2,700 tons for the five years 1926-30. The timbers imported were chiefly *gurjun*, *pyinkado*, rosewood, Indian silver greywood and Indian laurel.

Whilst the more expensive hardwoods have made some progress towards recovery, cost continues to be the main factor, and freight and extraction charges handicap Indian timbers. Teak *is an outstanding timber, with an established reputation for* certain purposes. Other Indian timbers have to face heavy competition from all sources of supply. Decorative woods are, in addition, subject to the dictates of fashion, and the demand for other than figured woods is lessened by the ever-increasing use of plywood and veneers, notably in the cabinet-making and *kindred industries.*

*Chapter written by Sir H. W. A, Watson, Timber Adviser to the High Commissioner for India,

Deliveries of Indian timbers through the agency of this office were 1,053 tons in 1935-36 as against 1,005 tons in 1934-35.

Sales were effected for 1,006 tons in 1935-36 as against 1,341 tons in 1934-35. The reduced sales are due in part to limitation of output from the Andamans and in part to the prices offered being unremunerative. The Board of Trade returns indicate that hardwood prices have dropped by some 33 per cent. since 1929.

Enquiries

Commercial enquiries of the year analyse as follows:

Enquiries resulting in sales	24
Enquiries for specified quantities of timber not resulting in sales	20
Tentative enquiries regarding supplies and production	5
Total	49

There were also the usual enquiries from consumers regarding sources from which timbers could be obtained, etc., and in several cases requests for the identification of timbers.

There is little prospect of introducing any new timber to the United Kindgom market unless it has been proved to have outstanding qualities and, in the case of an industrial timber, the price must be competitive.

Yon (Anogeissus acuminata) has outstanding merits for hammer and pick handles. The special qualities of this timber have led to enquiries as to its possible use for skis. This possibility is being examined.

Panels and a secretaire in *yinma* (*Chickrassia tabularis*) were received from Burma and five logs of this timber were imported. *Yinma* belongs to the mahogany family. The timber has good working qualities and an exceptionally pleasing appearance.

Propaganda

The principal Burma shippers of teak again staged a very effective display of teak at the British Industries Fair at Olympia. Teak was also conspicuous as garden furniture in other parts of the Fair, but apart from teak and a little laurel funiture, no Indian timbers were in evidence. The furniture exhibits were, with few exceptions, of the usual oak and walnut type.

In addition to showing teak at Olympia, the Burma teak shippers have issued a very attractive brochure, with photographs illustrating the history and uses of teak.

The Timber Development Association continues its good work in the interests of timber. Amongst their activities they are responsible for a monthly periodical, *Wood*, which draws attention to the manifold uses of wood, past, present, and prospective. This periodical is beautifully illustrated and contains instructive articles written in a popular manner. Its first issue, in January 1936, showed a coloured plate of Indian laurel,

The Timber Development Association also arranged a timber exhibit at Charing Cross Underground Station, illustrating, by photographs and veneers, the uses of wood and the problems connected with their use.

The Second International Conference on Timber Utilisation and Research, organised by the Comite' International du Bois in conjunction with the Timber Development Association, was held in London at the close of the year. The session which dealt with all aspects of timber utilisation, should do much to stimulate interest in wood and its by-products.

The *Architectural Review* issued a special timber number, and the *Times Trade and Engineering* issue for November contained a special "Timber Trades Section."

The most notable examples of the use of wood during the year were in the P. & O. liner "Strathmore" and the Cunard liner "Queen Mary." Teak was naturally the timber used in the decks and fittings. About 1,000 tons of teak were used in the "Queen Mary." In both vessels the saloons and the principal state rooms were panelled in wood. The decorative woods used included Indian laurel and Indian silver-grey wood. The former timber was used as a border in an oak floor in the "Queen Mary," in addition to its use for panelling.

ROOT SUCKERS FROM SEMAL (BOMBAX MALABARICUM)

BY D. STEWART, I.F.S., DEPUTY CONSERVATOR OF FORESTS

(*United Provinces Forest Leaflets, No.* 4, *December* 1935.)

In a two hundred acre clearfelling area for plantation in North Gadgadia compartment 2, Tarai and Bhabar Estates forest division, several hundred large *semal* trees over 28 inches diameter were felled. In the plantation area lines fifteen feet apart and 4 inches deep were dug in April and May for sowings of *khair*, *semal* and *sissoo*. Where the lines cross *semal* roots and the roots have been exposed and wounded by *phowrahs* in the digging of the lines, vigorous *semal* root suckers have resulted almost always, and these are now 4 feet to 6 feet high at the end of the first rains. The size of the original *semal* tree does not seem to make much difference as root suckers have resulted from very big trees. The suckers come up as far as thirty yards from the felled tree.

This suggests an easy method of obtaining regeneration of *semal* from root suckers at small expense where *semal* fellings are in progress. Unfortunately *semal* is a species which is very badly browsed by cattle and wild animals and it is doubtful whether any large measure of success can be obtained outside fenced plantation areas. It is, however, worth trying on an experimental scale to see whether the *semal* root suckers will survive the browsing. A small area might be fenced for comparison.

LAC RESEARCH

Dr. Ramkanta Bhattacharye, one of the three research chemists who has been doing research in lac in England on behalf of the Indian Lac Cess Committee since 1933, has had his term of office extended by a further period of five years. The Indian Lac Cess Committee formed the London Shellac Research Bureau three years

ago to carry on research in lac. It is a recognised fact that for any natural raw material to hold its own in face of the keen competition of synthetic products of well-organised industries, every effort has to be made to improve and standardise the quality and stabilise the price. The possibilities of new uses should be explored and old methods of application should be modified to adopt changed conditions. Bakelite, glyphal, resins as well as cellulose products threaten lac with the fate of natural indigo and silk. These materials have behind them vast capital, scientific methods of production, organised research and clever salesmanship and propaganda. In the case of shellac, production is mostly primitive and control of price is purely speculative. Certain steps have been taken to organise research and it is gratifying to be assured that the experimental scheme sponsored by the Lac Cess Committee to establish a research centre in London to serve the lac-consuming industries has proved successful. In fact the wide field already covered by the result of research and the quality of published information by the Bureau have placed lac on the map. At meetings of the Faraday Society, the Oil and Colour Chemists' Association, the Society of Chemical Industry, the Institute of Plastic Industry, and various other organisations, chemistry and properties of lac have been discussed by the Indian scientists and Mr. J. A. Gibson (the Special Officer, Lac Inquiry), head of the London Shellac Research Bureau. Many users of lac have sent their problems to be solved and received free service and attention whenever possible. Several new methods of treating and modifying lac have been discovered. The success of the initial scheme has led to the continuation of the programme in London. Reorganisation and reconstruction of the scheme may be expected, but the policy will be maintained.—(*Capital, 3rd September* 1936.)

FIREPROOFED WOOD STANDS TERRIFIC TEST

Washington, D. C., April 20.—In a spectacular demonstration staged before officials and members of the American Building Officials Conference and filmed by Pathe News for public showing, a small frame building of chemically-treated wood withstood—in an amazing manner, according to Phillips A. Hayward, Chief of the Forest Products Division of the Department of Commerce—a most severe fire test. Tests were conducted at the plant of the Protexol Co., Kenilworth, N. J.

The small building approximating ten feet by twelve feet in size was of ordinary frame construction with a wood shingle roof. One outside wall was also shingled, the other three being sheathed only. There was a window in one side wall of the building and a window and a two-inch slab wood door in the front. To get the maximum draft possible for the fire, a 15-inch slot was left along the peak of the roof its entire length, and a six-inch slot was left at the ground line around the whole building circumference. All wood, including sash and doors, had been chemically treated, although the slab door had been treated some thirty years previously and had served for thirty years in a now dismantled New York hotel.

As the movies of the demonstration will show, a large flat steel tray of 10-inch depth placed inside the building on the ground was first filled with cotton waste. A tank truck of a nationally known oil company then pumped over this waste a layer

of highly inflammable liquid. The roof and outside walls of the building were likewise sprayed with the oil and ignited.

It was interesting to note that as soon as the inflammable liquid had been burned off the roof and sides of the structure, the flames quickly died down. Because of the chemical treatment, they were not able to get a hold on the wood or the shingles. Also, in spite of the hot flames generated on the outside walls and roof, and the fact that the inside held gallons of inflammable liquid, it was necessary to open the front door and throw in a flame to start the interior fire. The treated wood walls and shingles gave almost perfect heat insulation, and threw absolutely no hot embers.

The raging inferno on the inside of the structure was permitted to burn for thirty minutes at a temperature exceeding 1,800 degrees. By the end of twenty minutes the continued intense heat inside the structure had eaten through the end-wall peaks and the roof. The windows had of course gone out earlier. Not an ember was thrown and not a piece of wood went down flaming.

The interesting and outstanding conclusion reached as a result of the test is that wood or any combustible material, if properly treated and handled, can be used under any fire intensity and does not support combustion or add to the fire hazard. The fire immediately died away as soon as the oil had burned itself out.

While chemists and wood experts have long known that wood and shingles could be chemically treated against fire, this is believed to be the most spectacular demonstration of the fact ever held.—(*American Lumberman*, 2nd July 1936.)

THE USES OF ELM

It is not fully realised that the insulating value of timber framed walls is relatively high. The following figures show the actual units of heat (in B.T.U.s) lost per hour through one square foot of various types of wall construction for 30 degrees difference in temperature.

		B.T.U.s per sq. ft.
1.	Single glazed window	32·4
2.	6-in. concrete wall	17·1
3.	$4\frac{1}{2}$-in. brickwork lined with 1-in. plaster	16·0
4.	12-in. limestone wall	14·2
5.	9-in. brick wall plastered	12·3
6.	$4\frac{1}{2}$-in. brickwork lined with $\frac{5}{8}$-in. boarding	8·8
7.	4-in. framing weatherboarded, lined with $\frac{1}{2}$-in. wallboard	6·1

Restriction on Timber Buildings

Contrary to the general impression, the Ministry of Health model byelaws do not prohibit, nor do they unduly restrict, the use of timber in house construction.

In normal circumstances fire insurance for a timber house need be no higher than for a brick structure. Due attention should, of course, be paid to construction of flues, which should be of brick, and to electric wiring, which should be carried out by a reputable firm. A lining of any of the fibre wall boards in common use is probably more fire-resisting than a lining of asbestos cement sheet, which expands and disintegrates violently when subject to heat.—(*Quarterly Journal of Forestry*, July 1936.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for October 1936:

IMPORTS

ARTICLES	MONTH OF OCTOBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
Siam ..	247	15	..	52,948	1,353	..
French Indo-China ..	..	..	42	..	..	5,042
Other countries ..	..	148	..	..	14,943	..
Total ..	247	163	42	52,948	16,296	5,042
Hardwoods other than teak ..	..	..	..	..	..	..
Softwoods ..	836	934	2,120	50,372	56,110	1,30,973
Matchwoods ..	..	..	648	..	..	38,290
Unspecified ..	..	..	..	77,816	1,74,527	27,423
Firewood ..	64	58	28	789	870	414
Sandalwood ..	19	20	47	4,380	8,541	13,799
Total value of wood and timber ..	..	..	..	1,86,305	2,56,344	2,15,941
Manufactures of wood and timber—						
Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	192	..	..	49,545
Tea chests ..	..	..	..	2,97,208	6,12,829	3,70,636
Other manufactures of wood ..	..	..	..	1,66,887	2,12,572	1,21,212
Total value of manufactures of wood and timber ..	..	..	..	4,64,095	8,35,391	5,41,393
Other products of wood and timber—						
Wood pulp ..	47,102	17,072	16,404	3,12,281	1,10,235	1,01,454

IMPORTS

ARTICLES	SEVEN MONTHS, 1ST APRIL TO 31ST OCTOBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER Teakwood— Siam ..	3,111	217	735	3,25,940	20,414	94,738
French Indo-China ..	2,998	425	1,910	2,47,677	49,479	1,96,749
Other countries ..	..	148	542	..	14,965	66,505
Total ..	6,109	790	3,187	5,73,617	84,858	3,57,992
Hardwoods other than teak ..	..	..	..	..	..	..
Softwoods ..	6,357	6,599	10,877	4,18,859	4,05,118	6,57,503
Matchwoods ..	..	..	6,068	..	..	3,29,505
Unspecified ..	..	..	..	7,95,377	10,30,402	2,18,239
Firewood ..	424	344	195	10,342	5,168	2,913
Sandalwood ..	215	163	166	66,136	58,928	51,329
Total value of wood and timber ..	..	..	..	18,64,331	15,84,474	16,17,481
Manufactures of wood and timber— Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	1,704	..	..	3,91,186
Tea chests ..	..	..	..	23,11,173	29,11,445	25,43,994
Other manufactures of wood ..	..	..	..	11,85,134	14,45,517	8,50,016
Total value of manufactures of wood and timber ..	..	..	..	34,96,307	43,56,962	37,85,196
Other products of wood and timber— Wood pulp ..	2,45,736	2,00,104	1,22,987	16,43,280	13,19,699	7,94,373

EXPORTS

ARTICLES	OCTOBER					
	Quantity (Cubic Tons)			Value (Rupees)		
	1934	1935	1936	1934	1935	1936
Wood and Timber						
Teakwood—						
To United Kingdom ..	2,265	3,218	3,752	4,18,351	6,27,697	7,79,106
,, Germany ..	45	421	740	10,200	98,980	1,75,867
,, Belgium ..	23	122	4	3,812	21,670	967
,, Iraq ..	117	57	30	25,672	12,129	4,936
,, Ceylon ..	71	118	62	6,418	14,120	13,624
,, Union of South Africa ..	120	223	570	28,620	39,929	1,15,259
,, Portuguese East Africa ..	49	154	131	6,243	25,317	22,051
,, United States of America ..	199	17	..	58,278	3,766	..
,, Other countries ..	221	435	588	37,561	81,458	1,40,788
Total ..	3,110	4,765	5,877	5,95,155	9,25,066	12,52,598
Teak keys ..	200	428	355	30,000	62,550	49,393
Hardwoods other than teak ..	38	88	159	3,837	10,282	16,050
Unspecified ..	..	..	..	23,256	10,855	69,456
Firewood ..	..	1	..	..	11	..
Sandalwood—						
To United Kingdom ..	8	..	..	9,786	..	600
,, China (excluding Hong-Kong) ..	1	..	7	500	..	9,000
,, Japan ..	4	17	15	3,819	19,100	39,828
,, Anglo-Egyptian Sudan ..	4	..	3	4,180	..	2,900
,, United States of America ..	33	..	4	38,800	..	2,300
,, Other countries ..	3	3	3	3,550	3,660	2,725
Total ..	53	20	32	60,635	22,760	57,353
Total value of wood and timber ..	..	..	..	7,12,883	10,31,524	14,44,850
Manufactures of wood and timber—						
Furniture and cabinet-ware ..		No data.			No data.	
Other manufactures ..	..	..	..	7,518	9,810	15,987
Total value of manufactures of wood and timber ..	..	..	..	7,518	9,810	15,987
Other products of wood and timber ..		No data.			No data.	

EXPORTS

ARTICLES	SEVEN MONTHS, 1ST APRIL TO 31ST OCTOBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	15,986	19,720	24,125	35,63,017	38,37,928	49,79,890
,, Germany ..	1,261	3,379	2,730	3,10,552	7,86,364	6,52,347
,, Belgium ..	248	630	223	48,635	1,17,649	35,215
,, Iraq ..	611	726	356	1,24,027	1,31,154	66,560
,, Ceylon ..	323	516	659	36,461	64,374	91,862
,, Union of South Africa ..	2,073	2,069	3,663	4,73,226	3,42,640	7,43,377
,, Portuguese East Africa ..	173	687	1,012	28,545	1,19,215	1,71,462
,, United States of America ..	295	273	335	86,854	66,494	98,030
,, Other countries ..	2,451	2,763	3,523	4,49,529	5,17,696	7,71,644
Total ..	23,421	30,763	36,626	51,20,846	59,83,514	76,10,387
Teak keys ..	2,102	2,667	2,294	2,96,969	3,91,727	3,26,023
Hardwoods other than teak ..	530	480	1,049	53,329	50,148	1,09,804
Unspecified ..	..	..	..	1,60,819	2,16,592	3,27,648
Firewood ..	1	29	0	6	436	..
Sandalwood—						
To United Kingdom ..	30	12	5	38,736	14,560	5,200
,, China (excluding Hong-Kong) ..	36	8	59	58,685	11,700	71,560
,, Japan ..	28	66	46	32,657	71,399	98,631
,, Anglo-Egyptian Sudan ..	29	39	43	30,675	45,845	50,300
,, United States of America ..	263	224	288	3,08,800	2,27,480	3,14,948
,, Other countries ..	14	28	37	26,016	32,821	50,081
Total ..	400	377	478	4,95,569	4,03,805	5,90,720
Total value of wood and timber—	..	..	..	61,27,528	70,47,222	89,64,582
Manufactures of wood and timber—						
Furniture and cabinet-ware ..	..	No data.	..		No data.	
Other manufactures ..	..	..	..	78,753	57,366	64,912
Total value of manufactures of wood and timber ..	..	..	..	78,753	57,366	64,912
Other products of wood and timber ..	No data.			No data.		

INDIAN PLANTS REPUTED AS FISH-POISONS

By M. B. Raizada and B. S. Varma, Chemical Branch, F. R. I.

From times immemorial vegetable products of diverse nature have been used in various parts of the world for poisoning or stupefying fish, in order to facilitate their capture. The practice is one of great biological and economic interest and has generally attracted the attention of both travellers and scientists. In modern days this method of fishing has been condemned and in some countries declared illegal, consequently it has fallen completely in disuse.

2 There is no doubt that some of the plants used as fish-poisons are of great economical value and may in time to come be put to profitable use. The practical utility of some, specially the species of *Derris*, has already been shown in the manufacture of large quantities of efficient insecticides and likewise there are reasons to believe that others, such as *Tephrosia*, *Mundulea* and *Lonchocarpus*, could be used equally well, provided the plants occur in sufficiently large quantities and the material can be collected economically. At present the number of plants used in commerce as insecticides is rather small comprising Tobacco, Pyrethrum, Derris, Hellebore, etc.

3 The use of Derris as an insecticide was practised in the East long before its appearance in Europe and America. Chinese market-gardeners in Malaya frequently made use of an infusion of the pounded root in water and sprayed over the plant or brushed over with a bunch of feathers. For this purpose, vegetable insecticides are preferred to mineral insecticides, because of their being more toxic (rotenone, the active constituent of Derris and other fish-poisons, has been shown to be thirty times as toxic as lead arsenate to silk-worms), and also to

their being non-poisonous to human beings and warm-blooded animals. Since no special precautions or apparatus are required for their use, they find wider application. Biologists have always been wanting such an ideal insecticide, and the discovery of Derris and Pyrethrum which are both contact and stomach poisons to cold-blooded animals and insects, have therefore been of particular interest and use. Furthermore, the fact that both of these are found in quantity in the wild state, and their amenability to easy cultivation, adds much to their importance. Practically all the tuba root of commerce is derived from the Malay Archipelago. The area in Malay is estimated to be 3,500 acres of which 1,075 acres are plantation as a sole crop and the remainder being inter-planted with more permanent forms of cultivation. The exports are steadily increasing, an idea of which can be obtained from the table given below:

Year.	Amount in tons.	Value in $
1931	98	53,633
1932	210	92,334
1933	642	282,795

4 Another example of a vegetable insecticide easy of cultivation is afforded by Pyrethrum, the popularity of which can be gauged from the fact that its production in Japan, which at present supplies 70 per cent. of the world's requirements, rose from 279,931 lbs. in 1911 to 11,622,906 lbs. (priced at £569,038) in 1928, and 33,600,000 lbs. in 1936. Kenya is also now heading its way in the cultivation of the plant and might compete with Japan in its export trade.

5 The chemistry of Derris root is now fairly well known. Its constituents have been found to be rotenone, toxicarol, and deguelin; the relative amounts of these varying greatly in different samples of root. In commercial assay of Derris, therefore, the total resinous content is nowadays regarded as a measure of its toxicity irrespective

of the amount of crystalline rotenone that it may contain because the non-crystalline resin have also been proved to be as toxic as rotenone itself. Another example of a potent insecticide is afforded by the genus Tephrosia, which is one of the most interesting genus among fish-poison plants, not only on account of the large species of a toxic nature but on account of the wide range of the genus throughout both hemispheres. Tattersfield has examined *T. toxicaria*, a South American species, and *T. vogelii* from Tropical Africa and found that they both possess notable insecticidal properties due to the presence of tephrosin, their main constituent.

6 Apart from the toxicity to insects there are several other factors that have to be borne in mind when considering the possible use of plants as insecticides. One of the most important of these is whether the plant lends itself to easy cultivation, for it is only rarely that wild sources can be relied upon to give a sustained yield for any length of time. However common a plant may be in a locality, the question of collection of the material at the proper season of the year is always an expensive and bothersome affair, and for the success of a commercial enterprise it is necessary that the plant to be cultivated should give the required yield within a reasonable length of time, say, 3 to 5 years. It would be risky to recommend a plantation which may take 20 to 30 years to grow to a stage when it would yield the necessary material, for by then it is quite probable that the particular plant product may go out of fashion or may become replaced by a synthetic product.

7 It would not be out of place to mention here that most of the present-day commercial insecticides were originally used as fish-poisons and workers have generally concluded that any other plant material reputed as fish-poison would also be useful as an insecticide. This leads one to ask a natural question, "Are all piscicides insecticides?" or its converse, "Are all insecticides piscicides?" The latter statement is, however, not generally true, for we know that Pyrethrum, which yields pyrethrin as its active constituent, is a potent insecticide, but its use as a fish-poison is not reported anywhere. Nevertheless, there is a tendency for workers on fish-poisons to confuse between the two, and consequently in the lists of fish-poisons that have been

drawn up in the past even such plants as are merely insecticidal by virtue of their possessing an essential oil, etc., are included. In the present paper, while realizing these differences we are still inclined to include such plants, as we feel that most of these have been worked up chemically from an entirely different angle, and no thorough search, either biological or chemical, has been reported to have been made to explore their piscicidal value. For instance, *Artemisia* is included (some species of which yield Santonine, an anthelmintic, and which is not by any means a piscicide), but our excuse for doing so is, that either the essential oil or the resin which it contains may act as a fish-poison, and in the absence of any authoritative information to the contrary, it would be unreasonable to exclude it. *Antiaris* falls under another category, the poisons of which consist of two glucosides, antiarin α and β, but we are not aware of any scientific investigation which has established its use as a piscicide, although its latex has the reputation of being used by the tribes of Sumatra, Java and the Far East, as arrows and darts poison.

8. Workers in the past, apparently seem to have made no real distinction between the insect repellents or deterrents from actual poisons which cause heavy mortality. The same might be said of piscicide where stupefication has been confused with the death of the fish. The essential feature of both fish-poison and insecticide, on the other hand, should be that they actually kill by virtue of their being either contact poisons or stomach poisons and not merely act as stupefying or repelling agents, though the latter have their own usefulness and importance.

9. In view of the diverse nature of the plants used as insecticides and the active principles contained in them, it is quite probable that they may ultimately prove of great use in pharmacology and toxicology. It may, however, be pointed out that none of the plant products are to be regarded as universal insecticide. They have their own limitations as regards the virulence of their effect on certain insect species. Those that give cent per cent. mortality with one type of insects, may be stupefying to others and ineffective to most. So the specificity of their action should not be forgotten while dealing with such poisons and

biological investigations should be made before any attempt is made to cultivate any of these plants. Species of Derris, investigated so far, have been found to act both as contact insecticide and stomach poison and affect different classes of insects differently, according to the development of their nervous systems.

The method in which plants were employed for capturing fish varied greatly in different parts of the world, depending on the degree of the virulence of the parts of plants used. Burkill describes fishing with "Tuba" (Derris) in Malaya as follows: "When a big fish-hunt is planned, large amounts of pounded Derris root, soaked in water, are thrown into the river or pond to be fished, but when only a small hunt is planned, the pounded Derris may be mixed with clay and scraps of shrimps and waste fish and formed into a ball which is used like ground bait. In this case, perhaps some of the Derris gets into the fish's stomach, but the desired effect is usually, one might say always, brought about by absorption from the water through the gills. When whole canoes, full of water and pounded Derris, are upset into the river or pond, a very rapid stupefying of the fish occurs, enabling these to be lifted out of the water by hand. This is preceded by wild attempts of the victims to escape, in which they expose themselves to spearing, and in this spearing is the chief excitement of the sport."

Wray says, "The first effects of the poison on a fish are to cause it to make violent efforts to escape. Then the breathing becomes laboured and there is a sluggishness and uncertainty of movement; the next symptom is an increasing inability to maintain the ordinary position; then the fish turns on its back, rises to the surface, and the breathing becomes slower and finally ceases." The poison apparently acts on the respiratory organs of the fish, producing first a stupefying effect and later on death. That the poison not only acts upon the respiratory organs, as can be recognised from the difficulty in gasping for air and the widely opened gill covers, but also affects the nervous system to an equal degree is shown by the generally dilated pupils of the dying fish. According to Burkill "after the poisoning of the river with Derris, the water soon becomes pure again. This, of course, is chiefly by diffusion and also because aqueous solutions of the poison

decompose rather quickly. The destruction is more intense when a pond is treated, as there the water is not changed by any current, and becomes fouled through the killing and decomposition of all sort of unwanted animals." The time required to kill fish is different with different species. With some of the more active ones, such as certain species of Derris or Tephrosia, the fish are affected almost immediately the water is infected. Whereas with others several hours may elapse before the fish begin to rise to the surface of the water.

Howes mentions in the Kew Bulletin that the deleterious action of most fish-poisonous plants has been chemically proved to be due to the presence of alkaloidal substances. In view of the chemistry of the active constituents of fish-poison plants that have since been worked up it is obvious that the above statement is misleading. The present-day fish-poisons have been divided mainly into the following classes, namely those that contain (*a*) rotenone and allied substances such as deguelin, toxicarol or tephrosin, (*b*) tannins, (*c*) saponins and the like. We are not aware of any instances in which an alkaloid-bearing plant alone has been used as a contact poison.

There is, at present no evidence to prove that fish obtained by the use of these poisonous plants are in any way rendered unwholesome as an article of food, although a tendency to putrefy sooner than would be the case with unpoisoned fish has been observed.

In the following list it will be observed that plants recorded to be poisonous to fish are not confined to any one group or family, but belong to families widely separated geographically and phylogenetically. They also range in habit and form from small herb to large trees and huge climbers. The family which provides the largest number of species is no doubt Leguminosae—the Papilionaceae specially providing many of the more virulent forms.

In giving the chemistry of the plants listed below, only such constituents are mentioned as are likely to possess the poisonous elements responsible for killing fish; their other constituents, which are well known and established and from the point of view of the present note have no significance, have been omitted.

Bentham & Hooker's system of classification has been followed throughout. For the sake of convenience and easy reference an alphabetical list of Indian fish-poison plants is also appended.

Botanical Name.	Vernacular Name.	Area of abundance.	Parts used.	Chemistry and Remarks.
		MENISPERMACEAE		
1. *Anamirta paniculata* Colebr. (Syn. *A. Cocculus* Wight)	*Kakmari* (H and B)	Orissa	Berries	It is a powerful climber and is stated to be one of the best known and widely used Indian fish-poisons. The seeds and berries are extremely bitter and owe their poisonous properties to the presence of "picrotoxin" and the alkaloid "menispermin." A common method of using the berries is to powder and make into a thick paste with boiled rice. In this form even a small quantity is sufficient to render fish and birds insensible. As an alternative the berries are partly crushed and thrown into the water.
2. *Tinospora cordifolia* Miers.	*Gilo* (H) ..	Cultivated and wild all over India.	Bark ..	It is a climber and is reported to contain a small quantity of the alkaloid berberine. Recommended by the Conservator of Forests, Bengal for investigation.
		BIXACEAE		
3. *Gynocardia odorata* R. Br.	*Chaulmugra* (H and B)	Chittagong ..	Fruit-pulp, leaves and bark	A large evergreen tree readily recognised by the hard, round fruits which grow on the stem and main branches. It has been shown that when the seeds are crushed and brought into contact with water hydrocyanic acid, is formed owing to the presence in the seeds, of a cyanogenetic glucoside which has been isolated and designated as "gynocardin" (Power and Gornall).

4. *Hydnocarpus wightiana* Bl.	*Morotii* (Mal.) ..	Western Ghat ..	Fruit ..	A tall tree. According to Brandis the fruits are used to intoxicate fish; the oil from the seeds has antiseptic properties. The seeds of the allied species *H. venenata*, a native of Ceylon, yield a semi-solid oil used in skin diseases. Its seeds if eaten cause giddiness and are employed by the natives to poison fish. Their poisonous properties are, however, so strong that fish, thus killed, are rendered unfit for human consumption.
		TERNSTROEMIACEAE		
5. *Schima wallichii* Chois..	*Chilauni* (H) ..	Kalimpong Assam, Khasia Mountains and Chittagong.	Saw-dust and bark	A large tree, the bark of which causes irritation on human skin. The vernacular name indicates this property. Recommended by the Conservator of Forests, Bengal for investigation.
		RUTACEAE		
6. *Zanthoxylum alatum* Roxb.	*Tejbal, Timru* (H)..	Outer Himalayas and Khasia Mountains (Lower Kagan Valley, Jammu Kangra, Palampur.)	Bark ..	A prickly shrub with dense foliage which possesses a pungent aromatic taste and odour. The bark is largely used to intoxicate fish. According to Burkill, alkaloids have been found in the bark, similar to berberine, but nothing very precise has been established regarding the medicinally active substances which it holds. The Conservator of Forests, Bengal has recommended its roots, leaves and fruits for investigation.
		SIMARUBACEAE		
7. *Balanites roxburghii* Planch.	*Hingan, Hingota* (H)	Mysore, South Kanara and drier parts of India, as far as Delhi.	Bark Juice ..	A small thorny tree. Its bark yields a juice used in the Panch Mahals, Bombay, to poison fish (Watt). The soft parts of its fruit contain 7 per cent. "*saponin*" (L. Weil).

Botanical Name.	Vernacular Name.	Area of abundance.	Parts used.	Chemistry and Remarks.
		MELIACEAE		
8. *Walsura piscidia* Roxb. (Syn. ***Trichelia*** *trifoliata* Roxb.)	*Valsura* (Tam.) ..	Malabar and Travancore	Bark and fruit-pulp	A small tree of South India. The bark contains a resin anhydride, and a large quantity of tannin and saponin (Dymock). Roxburg and following him many other writers state that the bark is largely employed to intoxicate fish and that fish so caught are quite wholesome (Watt).
		SAPINDACEAE		
9. *Sapindus trifoliatus* Linn.	*Ritha* (H.B and Dec.)	S. India ..	Fruit and root-bark	A large handsome tree common about villages in South India and cultivated in Bengal and North India. The pericarp contains saponin which, according to Dymock amounts to 11·5 per cent. and lathers strongly with water. The root-bark also contains saponin (Kirtikar and Basu). It is mentioned by Watt as a fish-poison.
		LEGUMINOSAE		
10. *Acacia pennata* Willd.	*Agla. Alay* (H) *Shembi* (Mar.)	Oudh, Kumaon and W. Peninsula	Pulped fruit and stems.	A large prickly climber. According to Rodger the fruit-pulp and stems are used in Burma to poison fish. The following South African Acacias, *A. giraffae*, *A. lasiopetala* and *A. litakunensis* contain cyanogenetic substances (Steyn).
11. *Albizzia procera* Benth.	*Safed Siris* (H) ..	Subhimalayan tract from Jumna eastwards.	Bark ..	According to Watt the bark of this large tree if pounded and thrown into a pond stupefies fish. Burkill states that the bark of *A. saponaria* contains large amounts of saponine, being employed as soap throughout the eastern Malaysia. O. W. Barrett even suggests that it might pay to export it from the Philippines presumably for use in insecticides.

12. *Caesalpinia nuga* Ait.	*Kakumullu* (Mal.) ..	E. Bengal and W. Peninsula	Fruit and stem ..	It is a large scandent prickly shrub. According to Rodger fish-poisons are made from the pulped-up fruit and stems.
13. *Dalbergia stipulacea* Roxb.	*Tonnyok* (Lepchu)	Chittagong ..	Bark and root ..	It is a scandent shrub. According to the information supplied by the Conservator of Forests, Bengal, the bark and root of this are used to poison fish in Kalimpong.
14. *Derris elliptica* Benth.	*Tuba* (Malaya) ..	Assam ..	Root and root-bark	It is a large climber; the main constituents of which are rotenone, toxicarol and deguelin, which appear to be located for the most part in the root and root-bark. Observations made in Malaya on cultivated plants show that the fine lateral roots have always a higher toxic content than the large roots and the toxicity also varies with the age of the plant. It is stated that determinations of the ether extracts of roots of *D. elliptica* have shown that this variety should be harvested approximately 23 months after planting, the amount of toxic substance in the ether extract reaches a maximum about this period. Subsequently the toxic content declines until eventually the root becomes unreliable. *Derris scandens*. Benth, called *Gonj* in Hindi, and *Derris uliginosa*, Benth. found in the Subhimalayan tract up to Assam and Chittagong and on sea coasts and tidal river banks of both Peninsulas respectively, are also reported to contain rotenone and allied substances.
15. *Entada scandens* Benth.	*Gila* (B) ..	Central and Eastern Himalayas	Seed ..	The use of ***Entada*** as a fish-poison seems to be more common in the Philippine Island than elsewhere, as stated by Burkill. The seeds are reported to contain saponin (Bacon). According to the information supplied by the Conservator of Forests, Bengal, pulp of fruits are also employed as fish-poison.

Botanical Name.	Vernacular Name.	Area of abundance.	Parts used.	Chemistry and Remarks.
		LEGUMINOSAE—contd.		
16. *Millettia pachycarpa* Benth.	*Kharina* (Khasi Hills).	Assam and Khasi Hills.	Root ..	The roots of this large climber from Assam have been reported to contain rotenone, one of the active insecticidal principles of Derris. The same principle has also been isolated from *Millettia taiwaniana* Hayata from Formosa, used by the natives to paralyse fishes (T. Kariyone and others). Several other species of the genus Millettia are well known fish-poisons throughout the warmer parts of the world. *M. atropurpurea* Benth, reported by the Conservator of Forests, Bengal, from Chittagong Hill tracts and *M. auriculata* Baker, are the other two Indian species noted for their poisonous effects.
17. *Mimosa himalaya* Gamble. Syn. *M. rubicaulis* F. B. I. (in part).	*Agla Shiah-kanta* (H)	Dun forests and Kumaon	Bark ..	A straggling prickly shrub. It is recommended by the Conservator of Forests, Bengal, for investigation.
18. *Mundulea suberosa* Benth. Syn. ***M. Sericea*** (Willd.) Greenway.	*Pilavaram* ..	W. Peninsula, Mysore	Bark, seed and root	A small tree, reported to contain rotenone. Its seeds are extensively used to poison fish, the action being very rapid.
19. *Ougeinia dalbergioides* Benth.	*Sandan* (H) ..	Subhimalayan tract from the Sutlej to Sikkim.	Bark ..	A middle-sized deciduous tree with beautiful pale pink or white flowers. Its bark is astringent and is used to poison fish (Gamble).
20. *Pithecolobium bigeminum* Benth.	*Kachlora* (H) ..	Subhimalayan tract from Nepal eastwards, South Kanara Division.	Leaves and bark and seeds.	A large tree, cultivated and naturalised throughout India. Some species have been recorded as a piscicide in several eastern countries. The bark of *P. ellipticum* Hassak, according to Burkill, serves as a fish-poison in Java. Chopra records ***P. bigeminum*** as a fish-poison plant.

21.	*Pongamia glabra* Vent. (Syn. *Pongamia pinnata* Merr).	*Karanja* (H) and (Mar.).	Konkan and Oudh forests. Cultivated as a common roadside tree.	Seeds and roots ..	A moderate-sized tree with white and purple flowers. The seeds are said to kill fish, but towards men, while poisonous, they do not constitute a deadly poison. Also the roots have, as reported by Burkill, a rapid and an effective action. A 2 per cent. *P. glabra* oil-resin spray has been stated to be highly toxic against the nymph and adult stages of the green bug (*Coccus Viridis*) on coffee (Subramanian).
22.	*Tephrosia candida* DC.	*Lashtia* (H) ..	Subhimalayan tract, Khasia Hills, Assam.	Root-barkand leaves	A pretty shrub with cream-coloured flowers, which is widely distributed in tropical countries as a plantation cover-crop. It has been recorded by Gamble as a fish-poison in Eastern Bengal and Burma; the bark and leaves being chiefly used. *T. vogelii*, a native of tropical Africa, is employed in fishing and in the dry state is used as a flea-powder. It has already been adopted by Europeans in South Africa as an insecticide. Tephrosin is the active principle and is present in nearly all parts of the plant, the seeds having the largest amount, *viz.*, 0·35 per cent. (LeG. Worsely). Several other species of this genus are said to be fish-poisons.
			MYRTACEAE		
23.	*Barringtonia acutangula* Gaertn.	*Jujur* (H) and *Kumia* (B)	Subhimalayan tract, Bengal, the Peninsula.	Bark and root ..	A middle-sized tree. Its bark and roots are used to intoxicate fish. Most of the species carry saponins and on that account are fish-poisons. *B. racemosa* has been reported to possess insecticidal properties (LeG. Worsely). The bark of *B. speciosa* Forst. a small tree found in the Southern Deccan Peninsula, has been found, when tested, to be very toxic to fish, producing extreme excitement and exaggerated movement of the gills. It is said to be narcotic, stupefying the fish without killing.

Botanical Name.	Vernacular Name.	Area of abundance.	Parts used.	Chemistry and Remarks.
		SAMYDACEAE		
24. *Casearia graveolens* Dalz. (Syn. *C. glomerata* Roxb.)	*Chilla* (H) ..	Subhimalayan tract, Khasia Hills and W. Ghats.	Fruit ..	Deciduous shrubs or middle-sized trees, very common throughout the country. The pounded fruits are universally employed to poison fish.
and *C. tomentosa* Roxb. (Syn. *C. elliptica* Willd.)	Do.	Subhimalayan tract, Rajputana.	Do.	
		RUBIACEAE		
25. *Randia dumetorum* Lamk.	*Mainphal* (H) ..	Subhimalayan tract, Rajputana, Mysore and S. Kanara.	Root and fruit ..	A deciduous thorny shrub. According to Watt, the bruised root, as also the fruit, before it is ripe, is used to poison fish. In the Himalayas its berries serve as a substitute for soap.
		COMPOSITAE		
26. *Artemisia vulgaris* Linn.	*Nagdoun* (H) ..	Throughout the mountainous districts where forests have been cut for cultivation, *e.g.*, Darjeeling, Kalimpong and Kashmir.	Leaves and bark ..	It is a common herb abundant on waste lands. Leaves and bark *are reported to poison* fish.
27. *Eupatorium odoratum* Linn.	..	Bengal ..	Entire plant ..	It is a West Indian weed, now naturalized in Bengal. According to Rodger this species is used as a fish-poison in Burma. An American species, ***E. urticaefolium***, is reported to contain a toxic principle, tremetol. Sheep and cattle, poisoned by it, suffer from an acidosis and trembles (J. F. Couch).
		ERICACEAE		
28. *Rhododendron falconeri* Hk. f.	*Kurlinga* (Nep.) ..	Sikkim and Naga Hills.	Buds of flowers ..	A moderate-sized evergreen tree having cream-coloured flowers. It is reported by Chopra to contain a glucoside ericlin and is included amongst the list of fish-poison plants. A Chinese species, ***Rhododendron humnewellianum***, contains the toxic principle, andromedotoxin (Hung-Pi-Chu).

			PRIMULACEAE	
29. *Anagallis arvensis* L. var. *caerulea*.	*Jonkhmari* (H) ..	N. W. India and .. Bengal.	..	A small herb with pretty blue flowers. Both Watt and Chopra mention that it is used to intoxicate fish.
30. *Cyclamen persicum* Miller.	*Bakhur-i-Mirijam* (Ind. Baz.)	Persia and Cultivated in India.	Root ..	Dymock writes, " Pigs are said to eat the root with impunity, but fish are easily poisoned by it and frogs sicken and die after a few days. The drug is used medicinally by Indian physicians."
			MYRSINACEAE	
31. *Maesa indica* Wall.	*Nanapadhera* (Kumaon) *Atki* (Mar.)	Throughout India, N. E. Himalaya and the Deccan.	Leaves and bark ..	An ever-green gregarious shrub or small tree. According to Chopra, the leaves are used as fish-poison. Its bark is recommended by the Conservator of Forests, Bengal, for investigation.
			SAPOTACEAE	
32. *Bassia latifolia* Roxb. (Syn. *Madhuca latifolia* Mac.)	*Mahua* (H and B) Ippe (Tel.)	Subhimalayan tract and the Peninsula	Residual cake ..	A large tree, indigenous in the hills and planted elsewhere. The residue-cake, after the extraction of oil from the seeds, is said to be used to poison fish. Saponin or sapoglucoside has been reported in the seeds (Burkill). The manufacture and properties of agricultural poisons from the seeds of *B. latifolia* are discussed by Carlos.
			EBENACEAE	
33. *Diospyros montana* Roxb.	*Bistendu* (H) ..	Subhimalayan tract, Coorg and Mysore.	Fruits ..	The tree is often spinous. The fruits are used by the hillmen of Travancore to stupefy fish (M. Rama Rao). According to the same author the leaves of *D. paniculata* Dalz. are used to poison fish. Spies has found that the acetone extract of an allied species *D. maritima* is toxic to gold-fish.

Botanical Name.	Vernacular Name.	Area of abundance.	Parts used.	Chemistry and Remarks.
		APOCYNACEAE		
34. *Melodinus monogynus* Roxb.	*Sadul-kan* (B) ..	Assam, Khasia Hills	Bark ..	A tall milky climber with scented white flowers. The plant is poisonous to fish.
35. *Nerium odorum* Solander.	*Kaner* (H) ..	N. W. Himalaya and Siwalik. Also Commonly cultivated throughout India.	Bark and root ..	A large, common shrub, with showy flowers and brown silky seeds. The bark and root are poisonous. Its active principles are two glucosides, which are very strong poisons, producing a powerful depression of the heart (Pandse and Dutt).
		ASCLEPIADACEAE		
36. *Asclepias curassavica* Linn.	*Kakatundi* (H) ..	Bengal, Dun, Saharanpur and Coorg	Whole plant ..	It is indigenous in the West Indies but now naturalized as a weed in many parts, chiefly along water-courses. This plant, which is used in its native country and in Queensland for procuring fish, could with advantage be employed for the same purpose in India where it is abundant now. Many, if not most, of the species are poisonous. A bitter, yellow glucoside, asclepiadin, is the active substance, which has been extracted from *A. curassavica*, *A. tuberosa*, *A. galioides*, *A. mexicana* and a few others (Burkill).
		SCROPHULARIACEAE		
37. *Verbascum thapsus* Linn.	*Ban-tambaku* (H) ..	Temperate Himalaya, Kashmir to Bhutan	Seeds ..	It is a common woolly herb. Root, leaves and flowers all are supposed to have medicinal properties. The seeds are narcotic and are used to poison fish (Kirtikar and Basu).
		BIGNONIACEAE		
38. *Dolichandrone falcata* Seem. (Syn. *Bignonia spathacea* Roxb. and *Spathodea falcata* Wall.)	*Hawar* (H) *Meda singhi* (Mar.)	C. P., Berar and the Peninsula ..	Bark ..	A small deciduous tree, the bark of which, it is stated by many writers, is used as a fish-poison.

		LABIATEA		
39. *Eremostachys vicaryi* Benth.	*Gurgumo* (H) ..	Western Punjab and the Salt Range.	Entire plant ..	A fine, yellow-flowered annual plant. According to Stewart, it is said to be used in the Eusafzai, near Peshawar, for poisoning fish.
		THYMELAECEAE		
40. *Lasiosiphon eriocephalus* Dcne.	*Ramita* (Mar.) ..	W. Ghats ..	Leaves, bark and roots.	A small tree or large shrub. The bark is commonly used to poison fish. The insecticidal properties of this indigenous vegetable fish-poison have been studied by Subramanian.
41. *Linostoma decandrum* Wall.	..	Sylhet and Chittagong.	Fruit and stem ..	It is an evergreen scandent shrub. According to Rodger fish-poisons are made from the pulped-up fruit and stems.
		EUPHORBIACEAE		
42. *Cleistanthus collinus* Benth.	*Garar* (C. P.) ..	C. P. and the Deccan	Bark ..	It is a small tree found in the dry forests of the South. The bark is used as a fish-poison. The outer crust of the capsule is said by Ainslie and Roxburgh, to be exceedingly poisonous, as also the leaves and roots (Gamble). Dekker has examined the barker of *C. collinus* and disclosed the presence of a saponin, a tannin and phytosterol.
43. *Croton tiglium* Linn.	*Jamalgota* (H) ..	Lower Bhotan and Himalayas.	Fruit ..	It is a large shrub, native of the Malay Archipelago, cultivated and naturalised throughout tropical India. Burkill records that pounded seeds thrown into water stupefy fish. In all the districts of the Assam Valley, the crushed seeds of this species are largely used for the purpose. Spies finds that Croton resin from the oil and leaves is more toxic to gold-fish than rotenone.
44. *Euphorbia tirucalli* Linn.	*Sehud* (H) Nevli (Mar.).	Bengal, the Deccan and Mysore.	Milky juice ..	A large unarmed shrub, native of Africa but now naturalised in the drier parts of Bengal and South India. Cultivated elsewhere. The milk of this shrub is made use of for poisoning fish in Southern Maratha country and Goa. An allied species of N. S. Wales, *E. drummondii*, is reported to contain a cyanogenetic constituent (Seddon).

Botanical Name.	Vernacular Name.	Area of abundance.	Parts used.	Chemistry and Remarks.
		EUPHORBIACEAE		
45. *Flueggia leucopyrus* Willd.	*Salepan* (H)	Southern Punjab and Sind Outer Himalayas and Assam, Mysore and S. Kanara.	Bark and leaves ..	It is a large straggling thorny shrub of the dry regions, noticeable for its white, sweet berries. According to Dymock the plant is used as a *fish-poison*.
and *F. microcarpa* Blume.	*Dalme*, Rithoul (H)		Do.	It is large shrub or small tree found throughout India up to 5,000 ft. It is mentioned *by Dymock* as fish-poison.
46. *Sapium indicum* Willd.	*Huru* (B) ..	Sunderbans	Seeds ..	A small, evergreen milky tree found in the tidal forests. The juice of the tree is regarded poisonous. The seeds are used for intoxicating fish (Kirtikar and Basu).
		URTICACEAE		
47. *Antiaris toxicaria* Lesch.	*Karwat* (Mar.)	W. Ghats ..	Milky Juice. ..	A lofty tree found in the evergreen forests of the Western Ghats. The milk of the "upas tree" contains an acrid virulent poison (antiarin α and β) which is used in Java and neighbouring islands for poisoning arrows and darts, but its properties do not seem to be known in India. The idea that the South Indian species is not so poisonous, must have arisen from no such use being made of the latex here.
48. *Cannabis sativa* Linn. (Syn. *C. indica* Lamk.)	*Ganja* (H) ..	N. W. Himalaya	Stem, young leaves and flowers. ..	A tall, erect, annual herb found throughout India, wild only in the N. W. Himalaya. "Charas," the natural exudation of the plant contains 33 per cent. of a toxic red oil. This oil yields cannabinol, the pharmacologically-active principle of *C. indica* (Kirtikar and Basu). *Recommended* by the Conservator of Forests, Bengal, for investigation, for the plant is known in *Chittagong and Kurseong* as fish-poison and is used to drive away bugs from beds.

		JUGLANDACEAE		
49. *Juglans regia* Linn. (Walnut).	*Akhrot* (H) ..	N. W. Himalaya Nepal.	Rind of unripe fruit	The walnut is a large deciduous, aromatic tree. According to Kanjilal, the rind of the unripe fruit is used in Jaunsar and Tehri Garhwal to intoxicate fish.
		MYRICACEAE		
50. *Myrica nagi* Thurb. (Syn. *M. sapida* Wall).	*Kajphal* (H)	Outer Himalaya Kumaon and Khasia Hills and Lower Kurram valley.	Bark ..	It is a moderate-sized evergreen tree. The bark, which is the most valuable product of the tree, is used as an aromatic stimulant. D. Hooper (American Journal of Pharmacentics, 1894) says that 100 parts of the "kino" produced by the bark contains about 60 parts of pure tannic acid. According to Gamble, it is used in the Khasia Hills, to poison fish.
		GNETACEAE		
51. *Gnetum scandens* Roxb. (Syn. *G. edule* Bl.)	*Kumbal* (Mar.)	W. Ghats, Assam and E. Bengal, S. Kanara.	Leaves ..	A large, evergreen deciduous climber found in the evergreen forests. According to Watt, the leaves are used to poison fish in the Konkan. In the genus Gnetum, it is reported, that in most species there is present a saponin-like substance and a bitter principle (Dekker).
		CONIFERAE		
52. *Taxus baccata* Linn. (Yew).	*Birnis* (H. B. and B. O.)	Himalayas at 6-11,000 ft. and Khasi Hills.	Leaves and branches ..	A large, evergreen tree. References to the use of the leaves and branches of the Yew, for fish-poison, in various parts of Europe, have been made by certain writers and it is stated that as early as 1212 A. D. the use of yew-fishing was forbidden by Kaiser Fredrick II. Its use in India for this purpose, however, does not seem to be known. The alkaloid, taxin, is reported to be the poisoning constituent of the leaves of yew (Nickolson). Apart from taxin, taxicatin (a glucoside), sacchrose, raffinose, emulsin and invertin have been obtained from *T. baccata* (Lefebra).
		PALMEAE		
53. *Corypha umbraculifera* Linn.	*Talipanai* (M.) ..	Western Peninsula, cultivated in Tropical India.	Fruit ..	A palm up to 80 feet high. The fruit is reported to stupefy fish.

LIST OF INDIAN FISH-POISON PLANTS

BIBLIOGRAPHY

BACON	.. *Philipp. J. Sci.* 1,1007-36 (1906).
BRANDIS	.. Indian Trees (1907).
BURKILL	.. Dictionary of the Economic Products of Malay Peninsula (1935).
CARLOS	.. Fertilizer, Feeding Stuffs and Farm Supplies J. 16,302-3 (1931).
CHOPRA	.. *Indigenous Drugs of India* (1933).
COUCH	.. Science, 64, 456-7 (1926).
DEKKER	.. Pharm. Weekblad, 46, 16 and 29-34.
DYMOCK	.. Pharmacographia Indica (1890).
GAMBLE	.. Manual of Indian Timbers (1922).
GREENWAYS	.. Kew Bulletin (1936), pp. 245-250.
HOWES	.. *Fish-Poison Plants in Kew Bulletin* (1930), pp. 129-153.
HUNG-BI-CHU	.. Chinese J. Physiol, 5,115-24 (1931).
KANJILAL	.. Forest Flora of the Siwalik and Janusar Forest Divisions (1911).
KARIYONE AND OTHERS	.. J. Pharm. Soc. Japan, No. 500, 739-46 (1923).
KIRTIKAR AND BASU	.. Indian Medicinal Plants (1918).
LEFEBRA	.. J Pharm. Chim. 26, 241-54.
NICKOLSON	.. Univ. Cambridge Inst. Animal Path. III. Report of Director (1932-33), 169-99.
PANDSE AND DUTT	.. Bull. Acad. Sci. U. P., Agra and Oudh, 3, 209-14 (1934).
POWER AND GORNALL	.. Chem. Soc. Proc. (1904).
RAMA RAO	.. Flowering Plants of Travancore (1914).
RODGER	.. Handbook of the Forest Products of Burma (1936).
SEDDON	.. Agri. Gaz., N. S. Wales, 39, 777-82 (1928).
SPIES	.. J. Am. Chem. Soc. 57, 180-7 (1935).
STEWART	.. Punjab Plants (1869).

STEYN	.. Onderstepoort J. Vet. Sci. 4,399-415 (1935).
SUBRAMANIAM	.. J. Mysore Agri. and Exptl. Union, 13, 57-60 (1932).
WATT	.. *Dictionary of the Economic Products of* India (1885-1896).
WEIL	.. J. Ch. S. 1901, A. I., 648.
WORSLEY	.. Ann. App. Biol. 21, 649-69 (1934).

EROSION SURVEY OF THE UHL VALLEY

By R. Maclagan Gorrie, D.Sc., I.F.S.

In the summer of 1936 a detailed survey of erosion conditions in the catchment area of the Uhl river was undertaken at the request of the Chief Engineer, Electricity, Punjab, as some anxiety has been felt for the safety of the project owing to the occurrence of uncontrollable floods in the summer and a very poor free-water flow in the winter. It is not proposed to describe the engineering project in detail, but this survey constitutes the first attempt in India to make a detailed survey of erosion conditions, and a short outline of the methods adopted may, therefore, be of some interest to readers of the *Indian Forester*.

The catchment area of the Uhl and Lambadag rivers above Brot, where they are both utilised for power, consists of about 150 square miles, out of which only 12 square miles is in Mandi State and the rest in Kangra District. A previous examination of the ground had shown that the two chief sources of serious erosion are (*a*) itinerant graziers' thoroughfares through alpine pastures and (*b*) shifting cultivation and bad cultivation methods throughout the village lands. To these the Chief Engineer added a third—the danger of temporary stoppage of streams by damming by mud flows, earth screes, rock falls and collapse of snow bridges. Subsequent discussions have since focussed attention upon the ground below the 9,000 ft. contour, as it is largely from this lower belt, mostly farm land, that the important winter run-off is obtained when all the higher slopes are frost bound.

The problem is thus not purely a forest one but entails all forms of land use which lead to excessive silt carriage by the streams, and is primarily a matter of conserving the best possible plant cover for any given site.

A 4″ map tracing of the entire area was prepared from existing survey sheets. The 4″ scale allows ¼ square inch as a unit for erosion estimate on the map, equalling 10 acres on the ground, and this proved to be sufficiently detailed for our purpose, though actually many of the forest and alpine areas can be described in much larger units of area. Description was confined to the following indicator figures to be entered on the field map, as per examples given below. Full field notes were also kept in a notebook to supplement any points not fully covered by the indicator figures, such as local inhabitants' knowledge of grazing intensely, either permanent or seasonal, verbal accounts of landslips, torrent action floods, persistence of snow bridges, etc. The divisional forest staff supplied information about grazing incidence and how the actual incidence compares with what is laid down in the Forest Settlement for the area. Field notes indicated the best steps to be taken in effecting soil conservation measures.

The indicator figures were not considered as final and were modified after experience in the field had shown that this was desirable. Any changes made had to be applied retrospectively, however, to previous work so that the whole survey was maintained on the same basis.

Sub-heads for Erosion Survey Data—

C.=Cultivated F.=Forest G.=Grass land R.=Rock or cliff S.=Glaciers and snow bridges U.=Unstable screes	Plus the following figures used as enumerator.

Sub-divisions under C.=Cultivated—

1st digit. *Basis.* 1=Permanent, 2=Periodic, 3=Newly broken to plough, 4=Abandoned.

2nd digit. *Condition of terracing,* 1 to 9 in efficiency, descending scale.

3rd digit. *Crops.* 1=Rice, 2=Wheat or barley, 3=Gram or pulse, 4=Potatoes, 5=Maize.

Sub-divisions under F.=Forest—

1st digit. *Forest types.*

1. Ban oak.
2. Kharsu oak.
3. Miscellaneous broad-leaved scrub.
4. Deodar.
5. Kail.
6. Spruce and fir.
7. Chil.

2nd digit. *Soil cover and condition.*

1. Mainly grass.
2. Mainly grass heavily grazed.
3. Mainly herbs or ferns.
4. Mainly heavily grazed herbs.
5. Mainly shrubs.
6. Mainly heavily browsed shrubs.
7. Mainly cut or lopped shrubs.
8. Leaf litter.
9. No plant or litter cover.

3rd digit. *Condition of canopy.*

1. Canopy completely ruined by lopping, fellings and fire, etc.

2—8. Intermediate stages (values same as ordinary forest canopy percentages).

9. Canopy complete.

Sub-divisions under G.=Grass land—

1st digit. *Type.* 1. Village waste, 2. Private grazing grounds, 3. Alpine pastures.

2nd digit. *Use.* 1. Permanent grazing, 2. Seasonal grazing, 3. Grass-cutting.

3rd digit. *Incidence.* 1. Excess of buffaloes, 2. Excess of cattle, 3. Excess of sheep and goats, 4. Excessive all stock, 5. Excessive grass-cutting.

BHAI PURAN SINGH'S MAPPING PARTY IN THE UHL. MUCH OVER-GRAZED SCREE SLOPES IMMEDIATELY ABOVE THE RIVER NEAR PALAKSH. BETTER FRINGE OF FOREST ON OPPOSITE BANK BECAUSE THIS IS OFF THE MAIN VALLEY ROUTE. *Photo : R. M. Gorrie.*

BAD LANDSLIPS ON KANGRA SIDE OF THE UHL VALLEY ABOVE DEOT VILLAGE LANDS : 5 SLIPS VISIBLE MOSTLY DUE TO DENUDATION OF VILLAGE GRAZING GROUNDS
Photo : R. M. Gorrie.

Sub-divisions R. S. and U.—

No sub-division.

Denominator values for all above types—

1st digit. *Angle of slope;* 1 to 9 in 10° units with 9=90° vertical.
2nd digit. *Porosity of soil;* 1 to 9 in terms of capacity to absorb moisture.
3rd digit. *Soil types.*

1. Compact clay.
2. Clay loam.
3. Slaty loam.
4. Sandy loam.
5. Sand.
6. Boulders, pebbles, or scree.
7. Boulder clay or conglomerate.
8. Exposed gneiss or sheet rock.
9. Not allotted, to be used if necessary for any local type of soil.

4th digit. *Erosiveness of soil;* 1 to 9 in terms of liability to wash.
5th digit. *Liability to landslip* owing to torrent, glacier or snow-bed action.

Description of Torrent Mouths—

Area of debris cone (talus slope).
Slope of debris cone.
Signs of recent action.
Presence of slips in upper reaches.
Undercutting in upper reaches.
Snow bridges, glacier action or snow slides.

Examples—

1. $\frac{\text{C. } 194}{58740}$ Village cultivation, permanently but very badly terraced, under potato crop: angle of slope 50°, porosity high, very friable and easily eroded loam; no danger of landslip.

2. $\frac{\text{F. } 644}{48230}$ Spruce forest, herb cover grazed, canopy very open from lopping: slope 40%, soil very porous but not friable or easily eroded owing to needle litter and mould.

3. $\frac{\text{G. 114}}{42350}$ Village grazing common under permanent use, heavily grazed by all cattle; average slope 40°, porosity poor, friable shaley soil, scattered browsed shrubs, scanty grass: condition stable, but sheet erosion active.

4. $\frac{\text{G. 323}}{24494}$ Alpine pasture on a graziers' route heavily used seasonally; 20% slope, fairly porous; shallow sand overlying partly exposed gneiss, crumbling and very easily eroded.

5. $\frac{\text{U}}{82629}$ Steep bank of uncompacted torrent debris liable to slip *en masse.*

THE IRRIGATION OF DRY HILL SAL AREAS

By W. P. M. Warren, I. F. S.

Summary.—This article continues the discussion started in the *Indian Forester* in August 1935 and July 1936. The scheme begun in 1933 arrests the run-off of water from hillsides by contour channels. The water then percolates down through the soil instead of running to waste. The delayed run-off on an extensive scale would be a solution for flood problems allowing the plain's water to get away first.

Remarkable growth is being experienced where formerly hollow and stagheaded drought-stricken trees prevailed. The density of the stocking is also increasing. Blank areas many years old are filling up with regeneration.

The cost is low, only Rs. 100 per mile if dry rubble bunds for crossing nullahs are made.

The temperature at night in April (height 1,250 feet) under steady meteorological conditions was equivalent to that experienced at 3,000 feet in these parts.

Humidity and rainfall in May, under disturbed atmospheric conditions were higher than at any recording station nearby though its situation and topography were less favourable than at one station. Clouds in the latter half of this month were attracted each evening to the areas, with the often purely local precipitation of rain. Additional light showers in the day fell only in the area itself, and not outside, and so were not recorded.

The Editor has asked me to give "a clear indication of the basis on which the comparability of the climatic data is accepted" for the benefit of a wider public than those whose local knowledge will enable them to appreciate and interpret it. This is no easy task as I am not a meteorological expert. Moreover, I wish to avoid the controversy, which false arguments or overstatements of a case whose implications are only gradually being understood, would occasion. Had there been a meteorological station comparable in height topographical conditions,

incidence of forest, and distance from the Bay of Bengal, the task would have been easy, but in the absence of such a station, conclusions can be drawn only from a careful analysis of the contributing factors. These will now be examined in detail.

Maximum temperature.—No conclusions can be drawn as, unfortunately, a standard shade box had not been obtained. Ordinarily in the day time in the hot weather, one would not expect the influence of the normal dry type forest of the area to be very great in cooling the air, beyond the ordinary difference between half shade and open conditions, as the crop, very open with a density not more than 5, has only half the influence that a fully stocked crop would have. There is little reason to doubt that the increased leafage and the filling up of blank areas which irrigation is inducing, will exercise an increasing moderating influence on the temperature as time goes on, in addition to damper soil conditions due to greater storage of water.

Minimum temperature.—Apart from the ordinary influence of the forest, which we have seen in the past has not been at its maximum, it is believed that the valley, some 200 feet deep in front of the bungalow, facing south, and which is deeper towards the north-west, exercises an influence on the temperature at night. How much that influence is, is difficult to say. But long before irrigation was thought of, I had formed the opinion that the night temperature at Bamiaburu in the summer was slightly warmer, say, about 1° F. than at Ranchi. In other words that the combination of forest and topography had lowered the night temperature by about two degrees, for Bamiaburu with its 1,250 feet height should ordinarily be about 3° F. warmer than Ranchi whose height is 2,000 feet. (In these parts temperature drops approximately one degree Fahrenheit for every 250 feet rise in the height.) No great reliance of course can be placed upon such personal observations as they must obviously differ with the individual reactions to heat and cold.

It will be observed that Bamiaburu is now colder at night than Ranchi. In the month of April, when meteorological conditions were steady, the general average temperature was 4° F. less. On one day in March it was ten degrees cooler, and 7° cooler than Kalimpong

whose height is 4,800 feet! On the average, therefore, Bamiaburu, in April, enjoyed a night temperature seven degrees cooler than its altitude alone would give it, a temperature which one would normally expect at the 3,000 feet level in this latitude. The night temperature in May was only 6° F. less than Ranchi, but during that month the meteorological conditions were disturbed by influences from the Bay. Rainfall was general and this had a cooling effect everywhere.

The differences of relative humidity between the two places, which had caused the coolness of Bamiaburu in April, could not be maintained and so neither could the night temperatures. (Ranchi's humidity in April was 21 against Bamiaburu's 60, and 61·8 in May against 85. Nevertheless Bamiaburu's minimum temperature in May was still ·6° F. below that of Ranchi.)

Average humidity.—Although Bamiaburu's humidity was being approached by other places in May, it was still remarkable. Having a humidity of 23·2 in excess of Ranchi, and a temperature nearly one degree cooler at night, the saturation point would be reached sooner under unsettled meteorological conditions, and more rain might be expected to fall.

Rainfall.—In order to form a truer picture of the local rainfall in May, it is better to ignore the figures for Ranchi and Hazaribagh, and to include figures now available of nearer stations, such as Chakardharpur 20 miles and Sonua 8 miles away. The figures from east to west are: Jamshedpur 11 days of rain, Chakardharpur 14 days, Chaibassa (16 miles south of Chakardharpur) 10 days, Sonua (west of Chakardharpur) 9 days and Bamiaburu (south of Sonua) 15 days and Goilkera 7 days. Except for Chakardharpur and Bamiaburu the number of rainy days diminished from east to west as the disturbed conditions of Bengal were left behind, where it rained practically throughout the month at some station or other, sometimes nearly all.

Chakardharpur's heavier rain is attributed to the double range of high hills of Saitba Block stretching from south-west to south-east in which there are three ridges, one 2½ miles long above

SAL REGENERATION INDUCED BY IRRIGATION AT BAMIABURU MAY 1936. MANY ARE ONE YEAR OLD AND STILL RETAIN THEIR COTYLEDON LEAVES SHOWING THAT THEY HAVE NOT DIED BACK. KOLHAN DIVISION.

Photo : W. D. M. Warren.
20th May 1936.

CLOUD FORMATION OVER BAMIABURU INDUCED BY IRRIGATION.

Photo : J. S. Owden.
31st January 1936.

STUDY OF BARK OF FORMER Q. III-IV SAL SHOWING FISSURES CAUSED BY THE ACCELERATED GIRTH INCREMENT

Photo : W. D. M. Warren.
20th May 1936.

Robga, seven miles south-east of Chakardharpur, averaging 2,250—2,500 feet; a second, one mile long behind Tuia due south, averaging 2,000—2,150 feet and the third $2\frac{1}{2}$ miles long and ten miles away in the south-west near Hizia, averaging 2,000—2,250 feet, as well as several isolated peaks of 2,000 feet and 1,900 feet. The nearer ridges and peaks intercepted the clouds drifting over from the direction of Balasore in the third week of the month causing the comparatively heavy precipitation. Chaibassa to the windward side of these hills had ten days of rain as against Chakardharpur's 14. Chakardharpur had 11·59 inches of rain compared with 7·22 inches at Sonua and 3·97 inches at Goilkera—another support for the view that the monsoon was weaker in the west.

If Sonua had 9 days of rain, why should Bamiaburu, lying due south of it, have 15? With only one peak of more than 2,000 feet topograph, and a general average height of 1,250—1,800 feet to the west and north as against 950 feet at Sonua, its topography cannot be held wholly responsible for the six days extra rain. In fact from the 16th to the 22nd, while I was there topograph was not once responsible for causing precipitation of the five thunderstorms. On each occasion this peak, two miles to the west of the irrigation area, was free from cloud when rain first began to fall. Precipitation started as soon as the clouds reached the irrigated areas. (This is perhaps not surprising when we consider that the irrigated area had a temperature equivalent to 3,000 feet high, together with a high humidity.) At that time weather conditions in Orissa were disturbed and clouds came up each afternoon from the south-east in a very spectacular manner. The first clouds to arrive each day, remained as if waiting for something to happen, one cloud in the south-west, others to the north and north-west. None of them drifted away. At length a big cloud rose from the horizon in the south-east, its dark heavy mass, preceded by lighter, whiter-looking cumuli clouds, stretching up into the sky heading for Bamiaburu. As it approached it spread out enveloping one or more of the other clouds, lightning, followed by heavy thunder claps, occurred overhead, and down came the rain. This happened evening after evening until it seemed as

if Thor himself must be in them, shouting in anger at us for having meddled with atmospheric conditions. The clouds did not drift on as one would expect, but hovered over the area until they had deposited their rain. This explains why the rainfall was so local in character, and why Sonua, 8 miles, or even Kuira and Sangajata, six miles away north and south, did not receive the benefit of the earlier showers.

What caused these clouds to come up each evening as if to a magnet, and what made them stay until precipitation had ceased? Has the irrigation area caused a lone of low atmospheric pressure to form over it? Unless that is so, I cannot understand why, evening after evening, the clouds should be attracted to that one particular spot, or give us such a display of heaven's own awe-inspiring fire-works.

Perhaps we shall be able to explain these things better in future as we get more instruments, but just now they have caught us unprepared for such unusual happening. None of us thought, when the first trenches were dug, that the experiment would have such far-reaching results. Like a jewel of many facets, only a few have been shown at a time, and even now, one has the idea that Nature has not shown us all her tricks.

In conclusion, I wish to emphasise that it is the combination of forest land, height and irrigation which produces these results. In open country, the water of the soil would be evaporated too soon. The effect would not carry through to the next monsoon, as seems to be happening here. But seeing that five-sixths of Bihar forests consists of poor open, decrepit, almost worthless material, the importance to us of replacing it by these methods, with good, sound growth, cannot be exaggerated. Let those too who would deprecate the effect of water on forest growth pause for a moment. Green timber on the average contains 50 per cent. of water. There is a bigger percentage in the growing twigs, and probably 80-90 per cent. in the leaves (a turnip has 90 per cent. of its weight as water). Recently I read that in Bengal, where irrigation water was applied for late in the season, only 27 maunds per acre of a crop resulted, whereas those who had not gambled upon a good monsoon, but had applied for it

in time to get the full benefit, had crops of 45 maunds per acre. Paddy is the easiest of all crops to grow and is the least exacting in its soil requirements, providing it obtains water. Sugarcane will not grow without a good supply of it, however rich the soil (Imperial Bureau of Soil Science, Pamphlet 34).

A more convincing example to foresters, however, is the extraordinary growth put on by irrigated Madras teak. Laurie showed me photographs last year in Dehra Dun. In a district where teak is not indigenous, owing to the weak monsoon, a plantation of teak irrigated from a *bandh* above, grew to 21 feet in height in 18 months! Growth was continuous throughout the period. Whether such fast growth produces as strong a timber is for timber-testing research to discover. In our experiment irrigation is not continuous, practically ceasing with the end of the monsoon, so that probably little deterioration in the strength of the wood need be feared.

From many points of view the conviction is forced upon the impartial observer that the experiment is proceeding on sound lines, and that it is only a question of time before we prove this by facts, figures and photographs.

HOLLOCK REGENERATION

By J. N. Das, E. A. C. F., Assam.

*Summary.—Although the natural home of **Hollock** (Terminalia myriocarpa) is in* Upper Assam, it has not been in much demand until recent years. It has come to the forefront only recently. The well-known quadrant experiment (fully described in his article of June 1933 in the *Indian Forester* by Mr. A. R. Thomas, D. C. F.) has proved conclusively that regeneration of Hollock can be obtained if clearance of jungle with slight soil-breaking is made from 7 to 12 chains from the mother trees towards the wind direction (almost southward at Pasighat) at the time of its seedfall in January to March, and if timely weeding is done in rains. The cost of regeneration whether "*aided natural*" or "artificial" is almost the same. But there is still room for investigation as to how trees of best quality can be obtained quickly and with minimum expenditure.

Hollock (*Terminalia myriocarpa*) is no longer a third class timber, but it has become one of the important high class timbers in Assam. In my early days of service, about 20 years ago, nobody touched hollock. It was rather untouchable then. While among high-class

evergreen species in Upper Assam, which had their day at that time, were *ajhar* (*Lagerstrœmia flos-reginae*), *nahor* (*Mesua ferrea*), *cham* (*Artocarpus chaplash*), *amari* (*Amoora wallichii*) and *jutuli* (*Altingia excelsa*). These species have been so heavily exploited in the past that they cannot now be found in sufficient quantity to meet even the local requirements—their transport outside Assam being altogether out of question ; and the eyes of the traders and carpenters have now turned towards hollock. Economic necessity has to a great extent made hollock what it is now in the timber market in Assam.

The natural home of hollock is in Upper Assam, and it is found in abundance in the Sibsagar, Lakhimpur and Sadiya divisions. It is, however, available in small quantity in almost all the forest divisions of Assam.

Sibsagar and Lakhimpur supplied a large quantity of hollock in the shape of M. G. sleepers for treatment at Nahorkatiya for the last few years, while Sadiya resources are being utilized mainly in making plywood by the Assam Saw Mills & Timber Co., Ltd., stationed at Murkong Sellek in the Sadiya Frontier Tract. The Assam Railway Trading Co., at Margherita, take a quantity of hollock from Lakhimpur for their plywood, but their main species is hollong (*Dipterocarpus macrocarpus*).

An able article written by the late Mr. Martin, "Scrap the Lot," in the *Indian Forester* of October 1932, which was pregnant with facts and humour at the same time, is perhaps the first article written about the hollock of Assam. It was just then that he handed over the charge of the Sibsagar division to the writer of this note, and went to the Andamans. Alas, who ever dreamt that that would be our last meeting !

After this Mr. Thomas' article "Aided Natural Regeneration of Hollock" appeared in the *Indian Forester* of June 1933. He wrote this article in January 1933, just before handing over charge of the Sadiya division to the writer of this note, who had thus got an opportunity to observe and study the problem of hollock regeneration in these divisions for some time. A short note is given below on

some of his observations and experiments, particularly in the Sadiya division.

Aided Natural Regeneration—Except in Sadiya, hollock is regenerated artificially in all other divisions. In Sadiya, too, it is *only in a belt of the Pasighat Forests, where mother trees are available* standing in lines at right angles to the prevailing wind direct, that the method of aided natural regeneration is being adopted. In all other places a purely artificial method is followed. There is, however, very little difference between "aided natural regeneration" and "artificial regeneration" of hollock, as will be apparent from the table below showing the different operations carried out in each case :

Aided natural regeneration.	*Artificial regeneration.*
1. All trees are felled except the mother trees for seeds.	1. All trees are felled.
2. Underwood is cut flush to the ground.	2. Underwood is cut flush to the ground.
3. Lines are made and cleared for receiving seeds from the mother trees.	3. Lines are made and cleared for sowing seeds.
4. Soil is wounded by ploughing with an "Outenga" (*Dillenia indica*) root.	4. Soil is wounded by ploughing with an "Outenga" (*Dillenia indica*) root.
5. *Seeds fall naturally from the* mother trees.	5. *Seeds are sown by men.*
6. Weedings three to four times in the first year.	6. Weedings three to four times in the first year.
7. Transplanting in blanks.	7. Transplanting in blanks.

Thus it is obvious from the above statement that the only work that Nature does is the dispersion of seeds from the mother trees Otherwise it is one and the same process in both the cases. It will

not be out of place to mention here (it has also been mentioned by Mr. Thomas in his article) that to be sure of success, seeds are often sown in lines in "aided natural regeneration" areas as well, where natural seed-fall is not considered sufficient. And even then if any one line is not fully stocked, it is filled up by transplanting. It is perhaps more appropriate to call it "Nature's aiding artificial regeneration of hollock."

Cost.—Whether "aided" or "artificial" the cost is the same, except that the extra cost of seed collection, which is not more than Re. 1-8-0 per acre, is to be added to that of the latter. The cost of *kokat* felling, which is about Rs. 3/-per acre in the case of aided natural regeneration, is, however, borne by the Assam Saw Mills.

The following three operations are generally done during the first two years of a hollock plantation, either "aided" or "artificial."

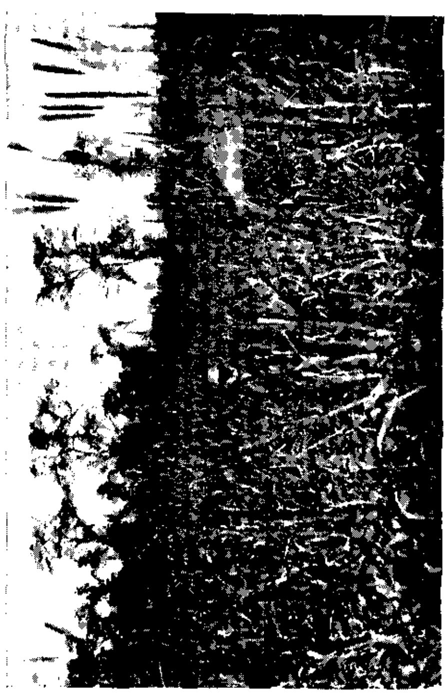
1. *Creation.*—It includes tree-felling, jungle-clearing, burning debris, wounding soil by departmental elephants (the cost of which is not taken into consideration), making lines (done by Forest Staff), seed collection and sowing (done by Forest Staff).

   Unlike sal plantations this operation is finished within the same financial year, *i.e., October to March.*

2. *Weeding.*—Three to four weedings (from April to November) are done, according to requirements, in one year. This expenditure is all incurred in the second financial year, when the plants are in their first year of life.

3. *First thinning and climber-cutting.*—It is now done in the second year, but falls in the third financial year from the date of creation.

The following table will show the cost of different operations done in the hollock plantations of the Sadiya division during 1932-35, both in the "aided" and "artificial" plots.



No. 1. 1 WEEDING—MORE NEEDED

No. 2. 2 WEEDINGS—MORE NEEDED

No. 3. 3 WEEDINGS—NO MORE REQUIRED

No. 4. 2 WEEDINGS—NO MORE REQUIRED

Year of creation.	Cost of creation per acre.		Cost of weeding per acre.		Cost of thinning per acre.		Remarks.
	"Aided" in Pasighat Forests.	"Artificial" in Poba Reserve.	"Aided" in Pasighat Forests.	"Artificial" in Poba Reserve.	"Aided" in Pasighat Forests.	"Artificial" in Poba Reserve.	
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
1932 ..	6 10 0	Not done	8 8 0	..	2 0 0	..	
1933 ..	11 11 0	12 9 0	6 12 0	4 4 0	2 3 0	2 0 0	
1934 ..	5 11 0	9 7 0	8 0 0 (a)	9 3 0 (b)	*	*	(a) This includes transplanting, as it was a bad seed year. (b) Clear felled area when transplanting was done to a great extent.
1935 ..	13 14 0 (c)	14 3 0	..	..	..	..	(c) It is not exactly an "aided" natural regeneration area, but a purely artificial area, as there were no mother trees left. * Not done when the note was written.

N. B.—In "aided" areas the cost of *kokat* felling is borne by the Assam Saw Mills and is excluded from the figures.

This difference in the cost of creation and other operations in different years is mainly due to the lines being not always of the same width, and to the varying intensity of jungle clearing and soil preparation according to the directions of different divisional forest officers. Some preferred wider lines, some narrower, some wanted removal of every piece of wood, etc., from the lines, some did not bother about it at all.

The area regenerated with aided natural process in 1933 at Pasighat was divided into 6 sub-blocks, of which sub-blocks 5 and 6 had 10′×10′ lines, while other blocks had either 40′×20′ lines or 20′×20′ lines. The following figures will show that the cost of weeding in 10′×10′ lines was much less than that of the wider lines.

Sub-block.	Area in acres.	1st Weeding.		2nd Weeding.		3rd Weeding.		Remarks
		Total.	Average.	Total.	Average.	Total.	Average.	
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
1	31	71 4 0	2 5 0	92 2 3	3 0 0	94 13 3	3 0 0	Lines 40′×20′ and 20′×20′
2	30	69 9 0	2 5 0	90 10 9	3 0 0	84 8 0	2 13 0	
3	30	72 12 0	2 7 0	110 2 9	3 11 0	79 7 6	2 11 0	
4	30	74 10 0	2 8 0	110 10 0	3 11 0	74 12 9	2 8 0	
5	32	60 14 6	1 15 0	80 0 0	2 8 0	Not	done	Lines 10′×10′
6	40	70 0 0	1 12 0	67 8 0	1 11 0	Not	done	,,

The advocates of "clear-felling," or in its absence making as wide lines as possible, and of 4 weedings in a year and 4 thinnings in 10 years' time, may say that it will give better stems, and it will look more beautiful. Quite so. But look at the expenditure. It must

not be forgotten that in practical forestry there is no room for luxury and the saving of even a pice is worth consideration. In making a plantation our aim should be that we create a forest and not a garden.

The cost of creation and upkeep of a hollock plantation has beeen reduced—

(*i*) by making narrower lines;

(*ii*) by not making intensive line clearing before the seed-fall or sowing as the case might be; and

(*iii*) by reducing the number of weedings where necessary.

Three weedings are generally done—once in April, again in June-July and, lastly, in September-October. Sometimes a 4th weeding in winter was done in certain cases, but it was really not necessary. The writer of this note selected 4 lines of more or less equal stocking in the 1933 Pasighat plantation, and one was weeded once, the 2nd line twice, while the 3rd and the 4th lines were weeded twice and thrice respectively. It will be clear from the photos that the line No. 1 of one weeding is full of grass, No. 2 is also not properly stocked, while Nos. 3 and 4 are quite well stocked. It can, therefore, be said with certainty that if timely weeding is done, it is not necessary to do more than three weedings, two may even be sufficient, but never one, while four is a luxury.

If the sowing is done late, say in April, two weedings may in almost all cases be sufficient. But it is still to be seen if the plants actually suffer much by losing two months growth, if the sowing is done in April instead of February. The plants in photo No. 4 were, however, grown in lines made in late March, and only two weedings were done there. But they are as big and healthy as others sown in lines in January and February, and where three weedings were done.

(*iv*) By raising a subsidiary crop in the area, either before the sowing of hollock, or with the crop of hollock in lines in between the hollock lines.

The following experiments were made by the writer of this note in small areas in the Poba plantation:

(1) *Kokat* felling was done in August 1933, and burning in October 1933, when an area of about 6 acres was cleared, soil was broken and mustard seeds were sown broadcast. The crop was reaped in January 1934 when the area was again cleared (and very little was to be cleared then) and debris burnt. Soil was again wounded before hollock seeds were sown. The following shows the expenditure and receipts from the sale proceeds of mustard:

Expenditure.	Rs.	a.	p.	*Receipts.*			
(1) *Kokat* felling, clearing and burning ..	33	4	0	Sale proceeds			
(2) Price of 25 seers of mustard seeds ..	4	11	0	of 45 maunds $31\frac{1}{2}$			
(3) Harvesting and threshing, etc. ..	57	9	0	Seers of mustard:			
					Rs.	a.	p.
Total ..	95	8	0		=120	3	0
					120	3	0
					95	8	0
				Net profit	24	11	0

Too much seed was used due to inexperience; it was subsequently found that 15 seers of mustard seeds were quite sufficient for the area. There was room for economy in harvesting as well.

(2) Cotton (Gossipium spp.) was dibbled in lines at irregular intervals when the first weeding was done in the hollock plantation of a small plot of about 5 acres in the Poba Reserve. The cost was practically nil. It was only Re. 1-8 for seed collection. But the price obtained from the sale of cotton was Rs. 94-4. No extra tending was necessary, as the weedings for hollock helped the cotton plants to grow.

The above two experiments show that the cost of plantation may be reduced by growing some subsidiary crop, either departmentally or through the taungya system.

The latter method was followed in the Sibsagar division in the Sola Reserve where the writer of this note arranged with the Nepalese that they would grow sugarcane in the lines between the hollock lines (there hollock lines were 6 feet wide, while space between the hollock lines was 14 feet from the sugarcane cultivation) and would do weedings for the department, and that they would be paid at Rs. 5 per acre of successful plantation, at the end of the second year of the plantation, when they would leave the area for a new plot. Unfortunately the taungya system could not be introduced in Sadiya, as there is no scarcity of cultivable land outside the Reserves.

Main causes of injury to plantation :

(1) Weeds—

(*a*) The main care one should take for the success of hollock plantation is that "timely weeding" must on no account be neglected. It was noticed that while doing first weeding in April, when the germination is not complete, forest officers often got disheartened by not finding sufficient seedlings in the area and discontinued further weeding—taking it as a failure (and thus actually made it a failure). But one with determination got a similar area successfully created by careful weedings in time without getting disheartened by the absence of sufficient seedlings at the time of first weeding, as the germination is noticed to continue till August—sometimes even up to September.

(*b*) Cutting weeds flush to the ground is always preferred to uprooting them, particularly during first and second weedings as the latter process often disturbs the root system of the young plants which die subsequently if so disturbed.

(II) Insects—

It was noticed for the last two years (1934 and 1935) that some larvæ (it is a pity they could not be identified) did a lot of damage to the young plants and the growth was very much retarded due to their attack. Except in the plot of 1927 much damage was not noticed in any other plot from dihamous.

(III) Climbers—

Climbers do much damage, but funds do not permit to give as much attention to this operation as is necessary. The Working Plan recently made, however, prescribes that it should be done once in the second year at the time of clearing, and afterwards during the fourth, sixth and tenth year, and thereafter every tenth year.

In conclusion it may be said that we now know enough to ensure the successful creation of a hollock plantation especially if timely weedings are done during the first year. As for the reduction of cost, it is still to be seen how best it can be done without causing the growth to suffer to a great extent. The Assam Silviculturist has, it is understood, taken it up in hand, so let us wait for the result.

STAND IMPROVEMENT

By J. N. Sen Gupta,

Experimental Assistant Silviculturist.

ABSTRACT.

The three basic methods (*viz.*, felling, girdling and poisoning) of eliminating undesirable trees have been compared in all essential details with a view to their practical application to experiments on natural regeneration in tropical evergreen forests.

The elimination of undesirable trees.—The Occasional Paper No. 50 of the 18th September 1935, issued from the Southern Forest Experiment Station, New Orleans, La., releases some interesting interim data about "killing undesirable hardwoods in Southern Forests," and their summary and tentative conclusions might be of general interest to Indian foresters, particularly those dealing with the problem of natural regeneration in mixed forests.

2. The improvement of forest stands is effected largely and often entirely by the felling or killing of undesirable trees. Trees are *undesirable* from the following considerations:

(*i*) Unmerchantable, even though of merchantable size.

(*ii*) Potentially unmerchantable even when larger because of species, form or quality.

(*iii*) Doubtfully merchantable, or of very low value, either now or in the future, and crowding or overtopping desirable or potential crop trees.

(*iv*) Defective and providing an abundant source of infection to desirable trees.

(*v*) Crowding more valuable trees to such an extent as to seriously retard their growth.

Stand improvement is an essential cultural operation in areas under regeneration, where the growth of young crop of important species is severely hampered by their valueless (hardwood) associates.

3. There are three basic methods of eliminating undesirable trees from forest stands, *viz.* (1) by felling or cutting, (2) by girdling, and (3) by poisoning. The criterion of success in killing undesirable hardwoods in stand-improvement work is largely the death of the crown, or at least the removal of the crown competition, and, secondarily, the prevention or reduction of undesirable sprouting of single trees or groups of trees.

4. *Felling.*—This is, obviously, a sure and immediately effective method, but except for the smallest trees it has two serious disadvantages, *viz.* (*i*) difficulty or impossibility of felling large-crowned, branchy wolf trees without causing damage to the very trees intended to be released, and (*ii*) time-consumption and expensiveness especially on large-scale operations. Felling takes from about 1½ to 9 times as long as girdling, depending on the diameter and species of the tree and the type of girdling. Small trees can usually be felled without causing damage and the relatively high cost (if any) is offset by the certainty of removing the crown competition. Felling by cutting close to the ground, and partial felling and bending over, are considered to be the best methods for killing or removing the crown competition of small hardwoods, up to 3 to 5 inches in diameter at breast height. But these methods are not sufficient by themselves (because of the sprouting that follows) if it is intended to release young seedlings less than about 5 feet high, in which case the sprouts will have to be cut close to the ground as often as necessary to prevent injury to the desirable plants.

5. *Girdling.*—This consists of cutting a complete ring of hacks or chips around a tree, and at any convenient height. To be effective, the girdle or ring must be absolutely *complete* or *continuous* and must extend through the bark and usually at least ½" into the sapwood. There are several types or methods of girdling, of which the simplest is to make a ring of single, overlapping, downward-slanting hacks with an axe, known as "singlehack" or "frill" or "ring-girdling." "Double-hacking" or "chip-girdling" consists of making two rings of downward-slanting axe hacks, the second about 2 to 6 inches above the first and resulting in the removal of chips. "Notching" or "Notch-girdling" involves the formation of a V-shaped notch by making both downward-and-upward-slanting strokes with an axe.

6. Girdling has so far proved the best method for killing larger hardwoods. A "double-hack" or "chip" girdle, exposing about a 4-inch band of sapwood, offers the best combination of effectiveness and cheapness, with ordinary labour and for all species. With unusually experienced and conscientious workmen (!) "single-hacking" or "frilling," with the edges of cuts separated by twisting the axe, is likely to be satisfactory and is cheaper. Around deep fire-scars or other cavities (*e.g.*, buttressed trees), where it is impossible to cut through completely the living tissues within the inward curves, the girdle should be cut either *around* the cavity, outlining it with a complete, continuous series of cuts, or completely *above* the cavity. The labour cost varies greatly with the tool, the method, the species and the efficiency of labour.

7. Girdling protects a desirable young stand in an understorey from injury by falling trunks and crowns very much better than felling does. Girdled trees may, however, cause appreciable damage by their haphazard blowing over or breaking. Besides, the sprouts from girdled trees may also be more injurious to desirable reproduction than the ungirdled trees. This sprouting is related to the size of the tree, the species, the season of, and the period since, treatment. Observations have so far indicated (*i*) that sprouting decreases

steadily with increase in diameter—being negligible beyond about 11 inches at breast height, and (*ii*) that the trees girdled in October sprouted most, and in May sprouted least, with July intermediate.

8. *Poisoning.*—This consists of the application or injection of a chemical destructive to plant life—the common methods being to swab or pour the poison (*i*) into a complete girdle or "frill" around the tree, (*ii*) into one or more unconnected hacks, (*iii*) to swab it on a completely peeled section of the bole, (*iv*) to pour it into auger-holes bored into the bole, and (*v*) to spray the poison on the foliage. A number of different investigators in the United States and in India have shown that the first method is by far the most effective. As a modification of this, poisoning tools have been devised to reduce the cost by storing the solution in a long, tubular handle of an implement with a chisel-like cutting edge by which the solution is injected readily into the sapwood.

9. A large number of different chemicals have been tested, the most widely used being *arsenicals*. The commercial white arsenic, in particular, has been found to be very effective, either in a water solution or mixed with lye in it, in different proportions of $1 : \frac{1}{2} : 4$, $1 : 1 : 4$, $1 : 1 : 2$, $1 : 2 : 2$, $1 : 0 : 1$, $2 : \frac{1}{2} : 1$, and $4 : 1 : \frac{3}{8}$ of pounds of white arsenic, pounds of lye and gallons of water respectively. The solution must be prepared and handled very carefully as white arsenic is *very poisonous*. As most of these chemicals are poisonous to cattle and other games, their use must be limited to areas not frequented by, or effectively closed to, all kinds of livestock, for at least three to four weeks.

10. As different investigators using the same poison have frequently obtained different results, no specific conclusions can possibly be drawn, consequently there is no single "best" poison for killing trees. Some sort of girdling being an essential initial operation, the cost of poisoning is necessarily higher than only girdling (without poisoning). Experimental results have so far shown that poisoning is usually unnecessarily expensive and unjustified by any outstanding or consistent advantages. As regards rate of death or

damage caused by falling and sprouting of poisoned trees, they are affected by almost the same factors as merely girdled trees are. The poisons, as a group, may show a slight net advantage, but it is too uncertain and small to have any practical significance. There are relatively a few advantages of *effective* poisoning over simple girdling, *viz.* (*i*) that the trees are killed more quickly, (*ii*) that sprouting is reduced if not entirely prevented, and (*iii*) that survivals of simple girdling are also killed.

11. The elimination of *undesirable* trees in most of the natural regeneration experiments in the mixed evergreen forests of India and Malaya has been receiving attention for the last decade. Felling of smaller trees (approximately up to a girth of 1 foot) and ring-girdling of bigger ones (above 1 foot girth) have largely been in practice (*e.g.*, in Bengal, Coorg and the Andamans) and so far found to be quite effective. Our experience with the evergreens also bears out the fact that "double-hack" or "chip" girdling, exposing about a 4 to 6 inch band of sapwood is the most reliable method, ensuring the gradual (but not quick) process of death, which is so essential in hardening the existing regeneration (under altered conditions of light) that would otherwise suffer from too sudden an exposure.

12. Indian provinces have not yet carried out any large-scale experiments with *poisoning* bigger trees and are naturally sceptic about that in view of (*i*) the possible danger to which the games would also be exposed, (*ii*) the doubtful comparative (economic) advantages of these chemicals, and (*iii*) other considerations of staff and labour which are required to be skilful. In Malaya, however, revolutionary changes in the technique of natural regeneration have lately been made (since 1934-35) by the use of frill-girdles poisoned with 5 to 10 per cent. solutions of sodium arsenite. This was first introduced in 1931 and has now become the standard method of disposing of unwanted trees. The Malayan foresters claim that the rate at which the canopy is opened can be varied to a certain extent by the strength of the solution used, and that costs of regeneration improvement fellings have been considerably reduced.

NATURAL REGENERATION OF SAL IN BIJNI FORESTS OF GOALPARA

By D. C. Kaith,

Chief Forest Officer, Bijni Raj Court of Wards Estate, Goalpara District.

Some of the most important zamindary forests of the Goalpara district of Assam belong to the Raja of Bijni.

Mention of these forests was made by Mr. Milroy in his "Sal Regeneration in Assam," which appeared in the *Indian Forester* of September 1936.

These forests are scattered between the Eastern Bengal Railway line and the Brahmaputra towards the north and up to the border of the Garo Hills and Kamrup towards the south.

In fact, Bijni sal forests form a link between Goalpara and Kamrup sal forests.

In spite of the injuries caused by the human agency, the regeneration of sal is really wonderful. In fact it has become so aggressive in places that complete villages have to shift their sites to more open places.

The causes may be summarised as follows:

(1) *Grazing.*—Due to abundant and early rains in the Goalpara district a jungle begins to grow in April. Before the sal seed is mature there appears a dense growth of various grasses including *bâtâ* (thatch) and the sal seed gets very little chance of reaching the ground.

In the Bijni forests there are a lot of professional graziers who graze their cattle (buffaloes and cows) all the year round in these forests and it may be said that the herds are just sufficient to encourage sal regeneration, not to retard it.

When the time comes that there is not sufficient grass for all the cattle, some of them are shifted by the graziers themselves to better grazing grounds. More the cattle, less the number of years required to reduce the cover to a stage when the ground becomes ready to receive the seed for germination.

In a few years the seedlings establish themselves, shoot up and are so dense that no cattle can easily pass through nor can late fires burn severely because of the disappearance of grass.

Cattle even do not seem to bruise the young sal, but prefer to eat up all the tender creepers which are generally absent in such regeneration. Fires sweep across these forests in winter, but this danger is reduced by the absence of grass which is suppressed with the formation of dense canopy and also by grazing.

(2). *Temporary cultivation near sal forests.*—Neighbouring villagers and graziers open up cultivation where cattle have been sitting to take advantage of the fertility of the soil caused by manure. Such abandoned plots form excellent beds for sal regeneration.

(3). *Exploitation for revenue purposes.*—The past management has been to exploit these forests for the sole purpose of revenue and to-day trees over 5-6 feet in girth are rare. With the opening of the denser forests ruthlessly, thatch comes in and natural regeneration soon follows.

The combined evils of grazing, fires and severe exploitation have to a great extent proved a blessing in disguise.

The writer will be pleased to show these forests to officers interested in sal regeneration.

NOTE.—We also publish below a note of 5th June 1936 from the late Mr. Milroy, then Conservator of Forests, Assam, and a note by Sir Gerald Trevor, C.I.E., Inspector-General of Forests.

NOTE.

Thank you for your letter and the enclosure, which I am returning. I think myself that *light* grazing probably has some small beneficial effect, but we have achieved natural regeneration of sal in Kamrup where there never has been any grazing, and most of the natural regeneration round Boko has come up in the absence of grazing. I think that if you examine the zamindari forests near the railway line, you will see that the grazing over much of the areas has been so light as to be almost negligible.

SHILLONG, A. J. W. MILROY,
5th June 1936. *Conservator of Forests, Assam.*

NOTE.

I have seen some of these forests and other zamindari forests in Assam and regeneration is generally abundant due, in my opinion, to the following causes:

(1) A canopy of ·5 to ·6 of sal.

(2) The absence of heavy evergreen undergrowth owing to periodic fires which, however, are not excessive.

(3) Moderate grass mixed with shrubs which is no doubt to some extent produced under moderate grazing conditions.

On the other hand from a forest management point of view these forests are depressing as there is now little timber of any value in them.

Why does not the Chief Forest Officer now take up a definite area of his forest and regenerate it? There is no difficulty in doing this.

GERALD TREVOR.

IMPORT OF INDIAN TIMBERS TO THE UNITED KINGDOM

By Sir Hugh Watson.

Organisation of the Trade.—The channels by which Indian timbers reach the consumer in the United Kingdom are :

Brokers.—The broker acts as intermediary between shippers (from the East) and merchants elsewhere. A broker does not purchase on his own account, and therefore the contracts he issues to shippers (as sellers) and merchants (as buyers) must be identical. A broker's remuneration is his commission, payable by the shippers. The rate of commission varies, being usually 2½ per cent. in the case of shippers domiciled in the United Kingdom, and 4 to 5 per cent. when shippers are domiciled in the East. The commission usually covers the Del Credere risk, that is to say, it includes a guarantee of the buyer's solvency.

Merchants.—The merchant buys in large quantities, while a considerable portion of his sales may be of a retail nature. The merchant may, for example, be asked to supply one plank or one

square of a certain quality to a certain specification, or he may be asked to supply large quantities. Generally speaking, the function of the merchant is to take delivery—as it arrives at the port of discharge—of the timber which he has bought and to take it into stock against the anticipated requirements of the consumer. The merchant may, of course, have resold the timber "to arrive" to another merchant or to a consumer, in which event the second buyer takes delivery.

Consumers.—The consumer is the actual user of the timber. He usually obtains his requirements from the importing merchant either ex the latter's stock or for later delivery from the merchant's prospective arrivals.

Such, briefly, are the channels through which Indian timbers reach the consumer in the United Kingdom. They may become, at times, more devious by the intervention of more middlemen (*e.g.*, smaller merchants) or they may be shortened by the elimination of brokers or even of merchants. Instances of short-circuiting are not, however, of frequent occurrence, as claims on account of quality are apt to come back to the shippers. A consumer generally buys from a merchant subject to inspection on delivery with the right of rejection of any piece of timber not up to standard in respect of either quality or specification. Such timber having previously passed out of the control of the shipper, the brokers and merchants fulfil a very useful rôle in shouldering the responsibility for, and settling, any claims and disputes. The merchants who hold stocks are the corner-stone of the business, and it can be readily realised that if they find their customers are able to obtain supplies direct there is no inducement for them to continue taking an interest in that particular wood. It follows that if the shipper wishes to continue the business he has to cater for the requirements, retail or otherwise, of the consumer which in many cases is, of course, a business quite unsuitable for the shipper. The consumer usually relies on the merchant to guarantee the quality of the timber supplied. The shipper is seldom in a position to gauge what the consumer requires, and, apart from this, timber may suffer from degrade in transit.

Methods of Import.—Timber imported to the United Kingdom from India arrives under one of the following arrangements :

(*a*) *Consignment.*—The timber is despatched to a broker for sale on the market at the best price obtainable, and the profit or loss on the transaction depends, of course, on the result of this sale. Consignment business is not of large extent, but this method of importing is advisable in the case of special timber, such as figured logs, of which the proper value cannot be estimated until the wood has arrived and been inspected, and also when it is a case of testing the market in the case of some new timber. Rosewood in the smaller girths is sent forward on consignment at intervals, but the teak trade, except in so far as regards occasional consignments of "figured" wood, is almost entirely done by means of C. I. F. contracts for forward shipment.

(*b*) *C. I. F. Contract.*—The letters "C. I. F." stand for COST, INSURANCE, FREIGHT, and under such a contract the shipper pays all charges to the port of destination, the only cost borne by the buyer being that of removing the timber from the vessel. This is the usual form of contract under which Indian timber is sold.

(*c*) *F. O. B. Contract.*—In which the timber is placed free of all charges on board the vessel at port of shipment. The seller may, and probably would, arrange freight on behalf of the buyer, or, of course, the buyer could make his own arrangements in this regard. This form of contract, however, is very unusual in the case of Indian timbers.

Timber on arrival in the United Kingdom.—On arrival, timber may be unloaded direct on to the wharf, but in many cases, particularly in London, delivery is taken overside into barges, and the wood taken direct to the merchants' yards. The landing charges and port dues are borne by the consigner in the case of consignments (unless the wood is sold on C. I. F. terms before arrival), and by the merchant in the case of timber shipped under contract. From the date of arrival the cost of the timber is increased by the usual debits for storage, insurance, interest, etc., and these charges have to be borne in mind by the merchant when he is calculating his reselling price.

In some cases the functions of the merchant are confined to passing the timber and transferring it direct to the consumers yards. This would frequently be the case in dealing with railway contracts for forward shipment.

Measurement.—Unless otherwise agreed round logs and roughly squared logs are measured and sold on Hoppus' system, *i.e.*, the length is multiplied by the square of the quarter girth taken in the middle of the log. When measuring on Hoppus' basis, quarter girth is taken to ¼ inch, and the lengths are taken to ½ foot, *e.g.*, a log 12½ feet long would be contented as 12½ feet. Logs from 12 feet and up to under 12½ feet long would be contented as 12 feet, and logs from 12 feet 6 inches and up to under 13 feet would be contented as 12½ feet. The girths are taken under bark or over bark with an allowance to make the measure equal to the under bark measure.

Another system of measurement under which round logs are sometimes sold is that known as Brokers' Tape Measure on Hoppus' System, with allowances for defects at the measurer's discretion.

The divisor in both these cases is 144.

Squared logs are usually measured on Calliper basis. The lengths are taken to ½ foot and the breadth and thickness to ¼ inch. The dimensions are taken in the middle of the log by Callipers. The contents are charged to an entire cubic foot, rejecting all fractions less than a cubic foot, provided the contents of the log are 5 feet cube or more and not less than 8 inches square and 10½ feet long.

Rosewood and sometimes other ornamental woods are sold at per ton weight.

Useful References.—"The British Lumber Market," by A. E. Boadle, American Trade Commissioner, published by the U. S. Department of Commerce.

"Timber Technicalities," second edition, by T. J. Stobart, published by Ernest Benn, Ltd., London.

Note.—I am indebted to Mr. J. R. Wright, of Messrs. C. Leary & Co., for revising my original note and to Mr. F. H. France, of Messrs. Steel Bros. & Co., Ltd., for further emendation.

REVIEWS

Forest Bibliography to 31st December 1933, Part I, compiled and published by the Department of Forestry, University of Oxford.

Although this publication does not actually form part of the scheme of the Imperial Forestry Institute for keeping foresters throughout the Empire in touch with the literature of their profession, it clears the decks as it were and forms a starting point from which the regular systematic circulation of information about current forest bibliography can proceed, and has been proceeding since March 1st, 1936.

The systematic referencing of forestry literature at the Oxford School of Forestry was started in 1920, and has been continued up to date in conjuction with the Imperial Forestry Institute since the foundation of the latter. All literature contained in the library of the Department of Forestry at Oxford has been dealt with, and this bibliography is probably the most complete list of forestry literature published in the English language at present in existence. A large number of titles of publications in German and French are also given

together with a few in other languages, restricted chiefly to those which have summaries in either English, French or German.

The arrangement is by date of publication under a simple broad subject classification, periodicals and other publications being kept separate under each head. No attempt has been made to follow the international decimal system of classification prepared by Dr. Flury and recently adopted by the International Union of Forest Research Organisations, but a concordance is given showing what heads under the decimal classification are included under the various subject heads in this bibliography. Though one could have wished for a more detailed classification, the present one makes it possible to look up all the available literature on a subject without very much trouble.

This volume, Part I, comprises the two heads of (A) General Forestry, and (B) Silviculture, (1) General and (2) Seed and seedlings. Subsequent parts will include seven other subheads of (B) Silviculture, and the other main heads (also sub-divided) of Protection, Utilization, Mensuration, Forest Valuation and Finance, Management, Forest Policy and Economics, and a number of other subjects. It is proposed to follow up these parts with a subsequent bibliography of literature from 1st January 1934 onwards, which will be arranged according to the new international decimal system.

The need for such bibliographies has been very widely felt by forest officers throughout India, and especially by research workers and institutes. Their compilation is a most laborious and tedious task, but the results will doubtless be gratefully appreciated by all who make use of them.

M. V. L.

AESTUNG (PRUNING)

By Dr. Hans Mayer-Wegelin

(*Publishers : Verlag Von M. and H. Schaper, Hanover, Germany.* *Price* 12·50 *R. M.*)

The appearance of this publication is timely and most welcome. Dr. Mayer-Wegelin is Professor of Forestry at Munden, in Hanover, and his book is written from the forestry point of view, with 83

photographic illustrations, all from forest trees, mainly spruce, pine, beech, birch and oak. More and more foresters in all parts of the world are coming round to the view that pruning is after all a practical proposition in forestry and, what is more, is an operation capable of giving reasonable return on the outlay involved. In India, the open supporters of pruning are at present very few in number, nor has the writer seen many instances of pruning in practice, but, judging from the marked tendency in its favour elsewhere, it seems certain that India will follow suit in due course.

A valuable part of this book is the bibliography which lists 270 references to books and papers on the subject in German, and—this comes as a welcome surprise as it is most unusual in Continental works—references to a further 119 in other languages, largely in English, both from the Empire and the U. S. A. This mass of literature is not all recent, of course, nor is it all primarily on pruning in forestry, but it provides some measure of the interest taken in the subject and of the value of the book under review to the busy forester who has no time, if he had the opportunity, to work through it.

Beginning with (1) an historical introduction, the successive sections of the book deal with (2) natural pruning, (3) rot consequent on pruning, (4) other effects of pruning, (5) the object of pruning, (6) preparation for pruning, (7) the operation of pruning, and (8) rules for pruning by species. Each section has a useful summary and the deductions to be drawn from it.

The general principles involved are, of course, familiar to us all whether we believe in pruning as a practicable and paying operation or not, but a quantitative treatment, such as is included in this book, is necessary to help us to reach a decision. The conclusions drawn are cautious and give the impression that the writer is no blind enthusiast for pruning in forestry, but believes that under the right conditions it is indeed worth while. The reasons for this impression may be illustrated by a rough translation of extracts from the final chapter giving the conclusions drawn from the available evidence for different species.

Spruce.—Spruce must be pruned as it does not clean itself naturally quickly enough . . . . Pruning should not be done in stands . . . opened up by snow or wind break or in qualities below IV . . . nor in stands over 8 inches crop diameter in quality Class II, $6\frac{1}{2}$ inches in quality Class III and 5 inches in quality Class IV. Green branches should not be pruned flush with the stem and on the rare occasions where green pruning is considered advisable, the branches should be cut 6—12 inches out from the stem and the stump repruned 3—10 years later. (This is to give the tree time to put down a protective layer against the entrance of rot.) The number of stems per acre pruned depends on the crop diameter and the site quality, thus 160 with an average spacing of 15 feet for a crop of Quality Class III and diameter 4—6 inches cms. and the initial number should never exceed 320, spaced 10 feet apart. Pruning should be done up to a height of 20 or 25 feet.

Beech.—Beech should not be pruned. It cleans itself well enough and is particularly exposed to fungus infection.

Oak.—The timber value can be raised by pruning. Trees over 80 years old should not be pruned. The branches pruned are usually green and dry branches should be pruned as soon after death as possible. Up to an age of 30 years one should prune up to 140 stems per acre and thereafter up to 100, removing branches up to $2\frac{1}{2}$ inches diameter at the base in less vigorous individuals, and up to 4 inches in strong growth.

The cuts must be tarred over.

* * * * * *

Pruning should not be done during the period of vegetative growth. The use of saws is preferred to knives, shears, etc., as less likely to result in injury. Light types of ladders are described and recommended for pruning at a height above the ground.

We recommend perusal of this useful book to all, particularly to those in charge of plantations.

H. G. C.

ABSTRACTS OF INDIAN FOREST LITERATURE PUBLISHED DURING OCTOBER TO DECEMBER 1936

ATKINSON, D. J. *A survey of the damage to teak timber by the beehole borer* (*Xyleutes ceramica* wlk.) *throughout the main teak-bearing forests of Burma* (*Lepidoptera, Cossidae*). *Ind. For. Rec.* (Ent.) *II* (1): 1-98. 2 *figs.* 1 *pl.* 9 *diagr.* *Maps* 2. 1936.—The incidence of beehole in a thousand teak trees in 56 localities in Burma is recorded in tabular statements and graphs. Average annual rainfall is an index of the severity of beehole which is greatest between the isohyets of 70 inches and 110 inches while below 55 inches the damage is tolerable. Hot weather temperature and humidity are also important factors. There is little reliable evidence for or against fire-protection, and fire is theoretically a factor favourable to the borer.

The true incidence of beehole is likely to be heavier in plantation than natural timber, other conditions being equal, but is less than the threefold increase hitherto accepted particularly in area of heavy incidence where the comparison is of greatest significance. Much of the natural forest timber is more heavily beeholed than much of the plantation timber and only the worst plantation timber will have difficulty in finding a market. Age-beehole and volume-beehole graphs show that rapid growth offsets a high population of borers; slow grown timber may be relatively more severely damaged commercially. The faster the growth the greater the volume of comparatively beehole-free timber. In young trees there is a preponderance of beeholes in the lower portions of the boles and at maturity the distribution is in an ascending series throughout the marketable bole-length.

Artificial regeneration of teak should be restricted to the light and moderate zones of incidence and 12 forest divisions are listed as permissible localities. Owing to considerable variation in local incidence within a small area the suitability of a locality for plantation should be determined by detailed ecological investigations. Where plantations will respond to heavy and repeated thinnings this remedy

should be adopted with the object of making the volume increment outstrip the borer increment.—*C. F. C. Beeson.*

CHATTERJEE, N. C. *Entomological Investigations on the Spike Disease of Sandal* (29), *Coreidae and Berytidae* (*Hemipt.*). *Ind. For. Rec.* (Ent.). *II* (7) : 157-75. 1936.—This paper lists 48 species of Coreidæ and Berytidæ frequenting the foliage of sandal (*Santalum album* Linn.) collected by the Forest Research Institute survey of the insect fauna of that tree in North Salem, Vellore, Madras and North Coorg forest divisions, South India.

Of the 48 species of Coreidæ 29 were found in Aiyur, 27 in Jawalagiri, 28 in Kottur and 24 in Fraserpet. Of the two species of Berytidæ, both of them occurred at Aiyur and Kottur and only one was found at Fraserpet and Jawalagiri. Brief notes on the life-history and bionomics are added and a table showing distribution and abundance of the various species is given.

Transmission experiments with *Homoeocerus signatus* Walk., and *Homoeocerus* sp., were undertaken. They gave negative results.—*C. F. C. Beeson.*

HAMILTON, A. P. F. and N. R. PRING. *Note on some factors which have contributed to the early revision of recent working plans. Punjab For. Rec. I* (1) : 1-15. 1936.—The necessity for early revision of recent working plans for forests worked under the Punjab shelterwood system is attributed to (1) the fire hazard, the effects of which were underestimated, (2) unsatisfactory arrangements for meeting the requirements of grazing and timber rights, (3) the exclusion of increment and pole crop volume from the yield calculations causing an area lay in Periodic Block I and forcing an extension of the period, (4) yield control difficulties in mixed woods, and (5) excessive rigidity in prescriptions. Proposals are made for avoiding these difficulties in future.—*M. V. Laurie.*

BEESON, C. F. C. *Forest Research and Indian Industry.* pp. 1—24. *Pl.* 11, *figs* 2. *Government of India,* 1936.—Deals with a special aspect of the work of the Forest Research Institute, Dehra Dun, *viz.*, the extent to which it is of use to other Government departments in India, such as the Railways and Army, to Indian States and

to industrialists concerned with the utilization of timber and forest produce.

The survey of the more important results of research on the growing tree, on timber and wood-using industries, and on forest produce other than timber, gives examples of practical achievements in seasoning, preservation, testing and identification of timbers, in remedies for white-ants, borers and dryrot, in assistance to industries concerned with paper, plywood, matches, oils, drugs, etc., and in the establishment and maintenance of plantations.

The examples are chosen to illustrate the great variety of contacts made by the Forest Research Institute with the industrial public and with other Government departments. Many of them express the financial value assignable to a remedy and to a new or improved process, and others show how new industries have been established as the result of research.—*C. F. C. Beeson.*

ANON. *Forest Research in India* 1935-36. *Part I. The Forest Research Institute.* 1-91. 1936.—The work of the year at the Institute is reviewed separately for the branches of Silviculture, Forest Economics, Forest Botany (including Mycology), Forest Entomology and Chemistry. Important results are published elsewhere.—*M. V. Laurie.*

TREVOR, C. G. *Annual Return of Statistics relating to Forest Administration in British India for the year* 1934-35. 1-32. *Diag.* 1. 1936.—Statistics are given for the year 1934-35 by provinces and totalled for the whole of India and Burma, under the following heads: Area of Forests, Progress of Forest Settlements, Demarcation and Maintenance of Boundaries, Progress in Working Plans, Expenditure on Communications and Buildings, Breaches of Forest Rules, Fire Protection, Causes of Forest Fires, Areas Closed and Open to Grazing, Protection from Cattle, Progress in Concentrated Regeneration and Afforestation, Outturn of Forest Produce, Export of Forest Produce, Details and Summary of Revenue and Expenditure, and a statement of revenue and expenditure and surplus for the last 36 years.—*M. V. Laurie.*

HOMFRAY, C. K. *Notes on thinning in plantations. Bengal For. Bull.* 1 : (*Silv. Series* 1). 1-45. 1936.—The thinning requirements in young crops of 18 timber species commonly planted in Bengal are discussed with tables of the number of trees per acre that should be left after thinning in plantations of given ages and heights of dominant trees on average sites.—*M. V. Laurie.*

MOBBS, E. C. *An approximate volume table for Haldu*(*Adina cordifolia*). *United Provinces For. Leaflets* 6 : 1-2. 1935.—A provisional volume table giving cubic content of commercial bole by diameter classes and girth classes for trees in the mixed forests of the United Provinces.—*M. V. Laurie.*

SAIED, I. Z. and D. D. KANGA. *Chemical examination of the Fruits of Solanum xanthocarpum. Proc. of the Ind. Aca. of Sciences*, IV. 255. 1936.—From the fruits of *Solanum xanthocarpum* a gluco-alkaloid $C_{44}H_{77}O_{18}N$, m. p. 288-89° C, named "Solancarpine" has been isolated. This yields an hydrolysis, the alkaloid $C_{26}H_{43}O_{3}N$, m. p. 197-98° C, named "Solancarpidine" and glucose, galactose and rhamnose. Besides the above a Sterol $C_{36}H_{54}O_{4}$, m.p. 248° C named "Carpesterol" has also been isolated.—*S. Krishna.*

BOSE, P. K. and A. C. ROY. *The Constitution of Ayapanin. J. Ind. Chem. Soc.* XIII, 586. 1936.—From the leaves of *Eupatorium ayapana* Vent. a crystalline substance named "Ayapanin" m. p. 114-15° C has been isolated. This appears to be 7-methoxycoumarin. Besides this two other crystalline substances, m. p. 220-21° C (Called "Ayapin ") and m. p. 109° C, respectively, have also been isolated.—*S. Krishna.*

AGARWAL, R. R. *Chemical examination of Cuscuta reflexa, Roxb. Jour. Ind. Chem Soc.* XIII. 531. 1936.—The seeds of *Cuscuta reflexa* have been found to contain : fixed oil (3 per cent.), cuscutalin (0·05 per cent.), a flavone colouring matter called amarbelin (0·1 per cent.), amorphous resins (1·0 per cent.) and reducing sugars. "Amarbelin" has the formula $C_{18}H_{16}O_{7}H_{2}O$ and appears to be dihydroxytrimethoxyflavone.—*S. Krishna.*

EXTRACTS

TIMBER

The Board of Trade Returns show that during the 9 months ending September 1936, imports to the United Kingdom of timber classed as unmanufactured from all sources of supply were valued at £30,109,935 as against a value of £25,443,910 during the corresponding period of 1935. Of these imports hardwoods, hewn and sawn, totalled 625,500 tons valued at £53,49,000 as against 572,000 tons valued at £4,670,000 in 1935.

Imports of sawn teak from India during the period were 34,640 tons valued at £669,880 in 1936 as against 26,700 tons valued at £475,700 in 1935. Figures for the imports of other timbers from India are not yet available.

Sales through the medium of this office totalled 141 tons and deliveries 299 tons during the quarter.

Imports of plywood during the first nine months of 1936 were 10,496,000 cubic feet valued at £3,039,800 as against 9,052,000 cubic feet valued at £2,537,000 for the same period in 1935. During these periods imports of veneers were valued at £610,600 for 1936 and £571,000 for 1935.

The Timber Development Association financed a specially constructed railway carriage to tour the country and advertise the uses of wood. The exhibit, which created considerable interest, apart from the panelling of the carriage included photographs illustrating the uses of timber, samples of timber, models of houses, seats, etc., some turned articles and an office to give information and to deal with enquiries.

Teak was conspicuous at the Building Exhibition at Olympia. Decorative timbers were shown almost entirely as veneers in the shape of flush doors and panelling of the flush type. Amongst these Indian silver grey wood, laurel, kokko, Andaman padauk, rosewood and figured teak were noticeable. In flooring also there is a tendency to use the more valuable species in the form of veneers.

The following figures have been taken from C. Leary & Co's London Market Report for the year 1936:

EAST INDIA TEAK

The following are the statistics for the last three years:

		1936—Loads			1935—Loads			1934—Loads		
		Timber.	Planks.	Boards and Scantlings.	Timber.	Planks.	Boards and Scantlings.	Timber.	Planks.	Boards and Scantlings.
Imports	Moulmein ..	82	115	114	nil	92	129	nil	57	nil
	Rangoon ..	1,159	1,772	3,117	407	769	1,401	51	392	923
	Bangkok ..	52	783	1,172	26	49	99	nil	225	225
	Java, etc. ..	nil	82	185	nil	15	125	nil	nil	nil
	Total ..	1,293	2,752	4,588	433	925	1,754	51	674	1,148
Deliveries	Moulmein ..	16	99	28	nil	66	89	nil	40	35
	Rangoon ..	483	919	2,593	681	1,030	1,798	320	837	1,134
	Bangkok ..	3	223	443	25	307	223	30	363	376
	Java, etc. ..	nil	30	130	nil	19	34	2	23	1
	Total ..	502	1,271	3,194	706	1,422	2,144	352	1,263	1,546
Stock, 31st Dec.	Moulmein ..	66	138	138	nil	122	52	nil	96	12
	Rangoon ..	1,032	1,689	876	356	836	352	630	1,097	749
	Bangkok ..	50	806	760	1	246	31	nil	504	155
	Java, etc. ..	2	157	146	2	105	91	2	109	nil
	Total ..	1,150	2,790	1,920	359	1,309	526	632	1,806	916

Padouk.—A little more interest taken, but only a small quantity sold.

Hardwood.—The consumption is satisfactory and, as conditions point to a continuance of good business, the demand will probably become active again in the near future.

Plywood.—Despite the continuance of unsettled world conditions, the volume of trade in plywood has shown a steady increase. Throughout the year a fairly good domestic demand has obtained encouraging confidence in forward purchasing on a gradually increasing scale. The general rise in values of most commodities was clearly evident during the latter half of the year and, whilst plywood values were slow to follow, ample evidence of the necessity for an increase in the prices of several varieties was forthcoming in the late autumn. Seasonal buying during the autumn has been satisfying in volume and the year closes with a steady market showing indications of increasing strength.

HANDBOOK OF NATIVE WOODY PLANTS OF THE UNITED STATES

BY WILLIAM R. VAN DERSAL

U. S. A. Department of Agriculture, Soil Conservation Service, July 1936.

INTRODUCTION

As every soil conservationist knows, there is a very definite relation between the density of the plant cover on the soil, the amount of soil lost through erosion, and the productivity of that soil. These three functions vary with each other in a regular and direct manner, and there is no reason to believe that they have not always done so. Soil is partly formed by vegetation, and vegetation is in good part a product of the soil. Taking the hint from our observation of natural conditions, we must expect to direct our efforts at erosion control toward vegetation, since it is known that erosion starts with the destruction of the plant cover, and that the kind and density of vegetation is more important in influencing run-off and erosion than is steepness of slope or intensity of rainfall. (Data from U. S. Forest Service, Intermontane Station, Ogden, Utah.)

For our purposes there are two kinds of vegetation which we may utilize—permanent and temporary. Under our present agricultural system we are concerned with the proper manipulation of cultivated crops in such a manner as to keep the maximum of cover on the soil as much of the time as we can. Such manipulated cultivable crops fall into the *temporary* class of vegetation. The *permanent* class includes plants which are permitted to remain on the ground without disturbance except to gather from them such periodic crops as they may produce. It is the purpose of this paper to consider in particular the woody species which can be utilized to aid in controlling erosion, and to examine some of the qualifications justifying their use in a planting programme.

Coincidental with the comparatively sudden demand by the Soil Conservation Service for millions of shrubs and trees to plant for erosion control, there has arisen an equally great demand for information about the species to be planted. It has become necessary to know where a species will grow, what soils it prefers, what

degree of drought or moisture it can endure, the nature and extent of its root-system, its susceptibility to insects and diseases, its weediness, its relation to other species, its use to the landowner as a crop plant, and its value as food or cover for wild life. Such information, approaching any degree of completeness, is remarkably difficult to get, and if it exists, must be laboriously assembled, bit by bit and piece by piece, from many different, and sometimes surprising, sources, although botanists, nurserymen, landscape gardeners, horticulturists, foresters and seedsmen have been gradually accumulating data of this sort for a very long time. It would therefore be absurd to say that we know nothing of the uses to which the bulk of our trees and shrubs can be put. The mere fact that a species has been described and named tells us at once that *something* is known about it. However, we still lack much information that would make for more intelligent use of our native plants.

Woody Plant Requirements for Erosion Control Planting

Many workers are of the opinion that a plant with a large root system will necessarily be the best one to hold soil in place. This idea is so universally held that it may not be amiss to review briefly just what takes place when a soil is eroded, especially by water. In doing this, we may obtain a clearer picture of how erosion can be prevented by planting vegetation.

In exceptional and rare instances, subterranean washing may take place, but under ordinary conditions the washing away of soil happens at the surface. It is the movement of soil particles downhill in water or into the air as dust that we wish to prevent. Since such movements occur in the very uppermost layer of the soil, our efforts will, of necessity, be directed to holding the top of the ground in place. Roots of woody plants do not, in themselves, offer much help in the top inch or so of soil; they penetrate deeper and may be said to be holding the soil in place *below* but not necessarily *at* the surface. It is thus clear that since erosion is greatest at the surface, roots have comparatively little to do with its prevention. As a matter of fact, they often increase erosion when water washes the covering soil off, and begins cascading over them. Under such conditions, with the water falling and acquiring greater force, roots only aggravate soil washing.

The surface layers of the soil can best be held in place by some sort of a protecting cover. This may consist of close-growing plants, litter, or a combination of the two. An effective protection for soil is afforded by a mat of grasses, which are among the best of all plants for erosion control. An equally good cover would consist of an established forest plus the litter produced by it. A third type might be made up of close-growing, thicket-forming shrubs plus the litter produced by them, or of a mat of entangled vines. Run-off and removal of soil is reduced to its minimum under such covers as these. Grass sod, although sometimes difficult to establish on steep slopes, offers the speediest control, followed by rapid-growing and slower-growing shrubs, then by forest trees. It is almost trite to mention that sod can be formed earlier than can a thicket of shrubbery and that the establishment of a forest and forest-litter takes the longest time of all.

It may not be out of place to emphasize the fact that as far as woody plants are concerned, roots are of relatively minor importance in controlling erosion. Observations in the field will show, however, that soil easily washes away from roots and that the better the surface of the soil is *covered* the less the soil washes. Experimental evidence has confirmed such observations. Kramer and Weaver (1936) conducted a series of tests on many kinds of plants, mostly grains and other herbs. They noticed accidentally that a single elm leaf protected the soil below it until a column, over three inches high, capped by the leaf, had been formed. Undercutting eventually toppled the column. In their experiments they discovered that it was not the soil-binding effect of roots that produced the most protection, but the plant cover which did not permit most of the water to come in direct contact with the soil. With the cover intact, *the binding capacity of the roots was greatly reinforced. Comparatively* little relation was found between the amount of underground parts and resistance to erosion. They found also that cover need not be living to be effective; any kind of cover protects the soil. The erosion control effect when the plant cover was intact exceeded that of underground parts alone many times.

Knowing that the surface of the soil is the critical area to be held, and that root systems may hence be largely neglected, except as they serve to hold out plants in place, we may indicate the plant characteristics which make for good erosion control. As these are considered, it should be kept in mind that much of the land on which planting is to be done has a certain cash value. If species can be used which produce a valuable crop as well as furnish erosion control, there is more justification for planting them. The factors governing the usefulness of plants in erosion control may be summarized as follows:

1. Such plants must be able to thrive under the climatic conditions *and in the* soil in which they are to be grown.

2. The greater their stolon, sucker, or rhizome range, or the more matted condition of their growth, the greater space they will cover and the more soil they may be expected to hold in place.

3. If the plants grow tall, the more litter they produce and the greater the water-holding capacity of the litter, the more erosion control they will accomplish.

4. The denser the foliage and the bushier the plants, the more protection from wind and rain they will offer to the soil; and the nearer ever-green they are, the longer the time during a year the protection will be offered.

5. The plants should be comparatively easy to propagate.

6. The more rapid-growing species will provide protection sooner than slower-growing species.

7. If plants furnish food and cover for wild life, their usefulness is increased through the aid they give in producing a game crop, and in conserving the valuable wild life resource.

8. The possession of such a character as ability to survive in spite of being grazed, is valuable.

9. The production of some crop, as timber, pulp, tannin, sugar, dye, comestible or ornamental fruit, or ornamental flowers, enhances the value of erosion control plants.

Certain species have characters which preclude use. A list would include plants which are :

(a) Poisonous to man, or cattle, either when taken internally or through dermatitic irritations.
(b) Secondary hosts to economically injurious fungi.
(c) Susceptible to insect damage, control of which is difficult.
(d) Excessively weedy and liable to crowd out more valuable and useful species.

THE SELECTION OF SPECIES FOR PLANTING

Certain fundamental aspects of survival must be recognized when a plant is placed among others to compete with them for a place in the sun. Survival values are often measured in terms of the *requirements* of this or that species. We speak of the tolerance of a plant for shade, sun, acid or alkaline soil, drought, and moisture. It is often considered that we know very little of the ability of one species to compete on the same ground and under the same conditions with another species. This is not true.

For at least 20,000 years in the northern United States, and for a much longer time in the southern part, the species comprising the flora of the country have been competing for position, settling themselves little by little into their respective ecological niches and associations. On any given area of ground there has grown a succession of associations of plants which, as they have contributed to the gradual modification of the soil (or rock) on which they grew, have eventually been replaced by plants of a different association. After sufficient time an association of plants has appeared which, under the existing environmental conditions, would appear to be the best adapted to the area. This group is often known as a climax. Regardless of the sophistry that there is never a climax because there is no such thing as a completely stabilised environment, the climax regions for the country have been more or less accurately mapped. Certain associations of grasses are considered to be the climax for the prairies and plains regions ; certain climax associations of deciduous trees appear in the eastern part of the country ; evergreen trees constitute a climax for the western coastal region ; and there is a xerophilous association of succulents and leatherly species which form the climax in the south-western deserts. It should be kept clearly in mind that every plant association, whether climax or preclimax, is the outcome of long ages of competition.

Enough work has been done so that we can, with some confidence, predict the climax for most areas, but it may be many years before we can predict the date of the climax, if that is ever possible. In a general way we know what species tend to occur together, and on what sites they are to be expected, in any given succession in any part of the country. To determine the ecological niche of a species, careful observation of it in its native undisturbed (or disturbed) habitat will usually demonstrate

where and how it fits into its environment. As Shantz ('35) has put it, "a thorough understanding of the natural vegetation climax and of the secondary stages leading to its re-establishment when it is once destroyed, is the best basis for a revegetation and erosion control programme."

Plant ecologists have, for many years, been engaged in unearthing the fundamental principles concerned *with the initiation, development, and maturity of plant associations* on given sites. The slow encroachment of lichens and mosses on bare rock, followed by the gradual appearance of higher plants, the development of soil and the invasion and succession of later associations tending toward a stable inter-relation between soil, vegetation, and climate, has long been known. The accumulation of debris, causing submerged water plants eventually to give way before the advancing shore plants, and these in turn before the successful competition of swamp forests and late dry-land forests, has been studied in considerable detail. Successions such as these, and those initiated by erosion, have been observed in many stages and under various conditions. As a result of such studies, the developmental concept of plant succession has evolved.

With these ideas in mind we may state a principle which any technician, who wishes to plant woody species to control erosion, would do well to remember, namely, *that careful observation of local vegetational successions, coupled with accurate* determination of the species involved will often point the way to the means for control of erosion. "Wherever one looks, nature has pointed the way to recovery" (Shantz, '35).

We have in this country one vast testing ground, containing many kinds of climate, soil, and site, wherein species have failed or succeeded for significantly long periods. As long as a species is planted within its known range of occurrence, in its proper site, as determined by observation of its so-called preferences, and is intermingled with other species in a ratio and position approaching natural conditions, we may be satisfied that, except for serious, local, accidental variations in environment, our plant will succeed ; that is, it will grow and thrive.

One of the arguments often advanced for the use of introduced species is that had we relied upon native plants we would not have the many crop plants upon which our agriculture is based, *consequently further introduction is necessary. A clear distinction,* however, should be made between crop plants which must be planted and cultivated each year, or every several years, and woody plants which are planted in the wild, untended, uncultivated, and which must depend for their existence upon any ability they may have successfully to compete with native species which will eventually grow around them or which are already there. In planting a species on sites where it must be able to survive competition, we cannot afford to select any others than those which have already shown themselves capable of composition in similar sites. If we expect to remove all competition through cultivation then such an argument would necessarily be invalid. Erosion cannot be controlled by cultivation, however, and most sites needing vegetation with woody plants are those which are being retired from cultivation, not those where cultivation is still to be practised.

There is no point in prolonging this discussion. The particular reason for its inclusion is that many technicians engaged in planting apparently do not understand clearly or at all that our first choice of species to plant on a given site should be those which have already been tested for that site, as natives to the region in question. Our second choice would be species which are not native; that is, exotic or introduced plants. *If it is certainly known that there is no native species which can grow in a* chosen site, then we are justified in turning to exotic forms. As Clements ('35) has put it, "nature is to be followed as closely as possible, and hence native materials alone are to be employed, preferably from the outset, but invariably in the final composition." Chapman ('36) claims further that until additional data can be obtained, "we are justified in making large-scale plantings only on the basis of ecological principles applied to the native species of the region."

This should not be interpreted to mean that the introduction of a foreign specie is "un-American" or undesirable. It is recognised, of course, that some introduction *of non-native* species has already been successfully accomplished, and these species are necessarily excepted from the preceding statements. But large-scale planting should be limited to species proven to be adapted to a given area, and known to be able to compete with plants now largely occupying the territory.

Planting Species for Wild Life and Erosion Control

It is obvious to those who have had some experience in landscaping or forestry that the old maxim about putting all of the eggs in one basket applied very well to the planting of woody species. The most important rule to follow, whether planting *for* timber, pulp, erosion control, wild life, or any combination of purposes, is that the species used must be varied; that the planting must be a mixture, not a pure stand. This is true for several reasons, namely:

1. Solid stands of plants favour the rapid spread of disease and insect pests. Fungi, as well as insects, find it easy to travel from one plant to another *of the same kind*. In mixed plantings, spread *is slower and control is consequently easier.* Isolation of individuals and groups from others of their own kind is the natural safeguard against infection. (St. Clair-Thompson, '29.)

2. Solid plantations of one species have been known for some time to result in depletion of the soil. Further, pure stands do not represent the maximum productive capacity of the soil. (St. Clair-Thompson, '29.)

3. Maximum interspersion of species ensures that all ecological niches will be filled. This results in a greater utilization of space, and better erosion control. Competition between individuals, and, therefore, waste of energy *is at its highest* in pure stands. (St. Clair-Thompson, '29.)

4. From the wild life standpoint, variety is absolutely essential. When one species of plant may not offer, another will. The effort should be made to attain a well-balanced habitat, approaching as nearly as possible the orderly confusion of nature. In addition, insectivorous birds are generally discouraged by pure stands, but *encouraged by mixtures. The encouragement of such birds leads to greater* control of injurious insects. (St. Clair-Thompson, '29.)

In England it has actually been found an economically justifiable practice to put up bird houses in forest plantation to attract insectivorous birds and thereby to ensure some control of insects. Proper mixing of species in planting should make such a practice unnecessary.

In planting mixture of species, as any landscape nurseryman knows, careful account must be taken of the height to which a given plant will grow. Indiscriminate planting of tall and low shrubs and trees will eventually result in the smaller species being crowded out of the picture by the large-growing ones. This situation indicates unwise planning and entails a useless waste of time, labour, and materials. Attention may be called here to the admirable planting suggestions put forward by Charles J. Kraebel in "Erosion Control on Mountain Roads" (1936). While his lists refer to California, the ideas expressed with regard to planting can be put to use in any region.

It is very essential that careful planning precede actual field operations. Press of work and the need for considerable planting to be done in a short space of time are often advanced as excuses for improper spacing, poor site and species selection, and faulty organization of the work. Actually such excuses are never valid, for the planting seasons are preceded by periods sufficiently long to permit of careful planning. Because of the impossibility of obtaining sufficient planting stock, it may often be necessary to substitute species, but this should be done most carefully, and if there is still a lack of proper species to do the particular job needed, it is better to be "safe" than "sorry." The planting should be partially or entirely deferred until the next season.

EROSION CONTROL CHARACTERS

Characters suggesting the use of a plant for erosion control include ability to—

(1) form thickets;
(2) root at nodes or along the stems of procumbent or decumbent or trailing branches;
(3) form suckers or root shoots, or root at the tips of declined branches;
(4) form mats;
(5) be aggressive in competition with other plants;
(6) resist drought and grazing;
(7) resist insect or fungus disease;
(8) grow rapidly;
(9) grow in many kinds of soil;
(10) tolerate alkaline, acid, saline, or barren, sterile soil;
(11) hold leaves the year round (evergreen) or late in the growing season;
(12) be of some other use than to control erosion;
(13) be available on the open market.

WILD LIFE FOOD AND COVER

Characters making a plant useful to wild life as food include:

1. Production of fruits, seeds, twigs, buds, catkings, leaves, or other parts eaten by birds, or mammals.

2. Persistence of fruits after maturity.

Citation of the stomach records of the Geological Survey are stated thus: "known to have been eaten by so many species of birds." Game birds are always mentioned specifically even though the record may show only one stomach examined which contained only a few seeds. Other reports, observations and writings are stated specifically for a locality or are stated as "noted by observers to be eaten by so many species." The Survey records were examined during March 1936, and checked in May, when any new records were inserted.

It is recognized that judgment of the value of a given plant as food for birds does not depend solely upon the number of bird species known to have eaten the fruit. The most dependable basis for such judgment is the percentage of any given food in the diet of the various species. Many fruits are present only as traces in the stomachs of a great many birds. They may not be staple or essential foods in any sense. Berries alone, for instance, are scarcely complete foods. The records of food eaten by birds are not yet complete for all parts of the country, nor for all seasons of the year, further, as the plant succession in a region proceeds, or as different species are planted or suppressed by man, changes in the diets of birds are to be expected. Intensive studies of one species must serve eventually to show more definitely the relation of the native fruits to bird dietaries.

However, if a plant is known to have been eaten, one is safer in choosing that species for use than in selecting at random some species about which nothing is known. Since really complete studies are still remarkably scarce, and since enough records are still not available, in many instances we are forced to rely upon the numbers of birds known to have eaten any given plant, to pass judgment on the plants we intend to use. The truly gigantic task of obtaining accurate data on bird foods, being prosecuted by the Biological Survey, tends always toward making the picture more complete. Further work by that Bureau will undoubtedly provide in time the information so greatly needed.

Characters making a plant useful to wild life as cover include—

(1) ability to form thickets;

(2) possession of thorns, spines, thick foliage, elaborate system of branches, evergreen habit, or ability to hold leaves late in the season;

(3) resistance to grazing.

Forage for Stock

Excellent forage plants have secondary value with respect to erosion control. If they provide forage and will control erosion under a practicable system of grazing, naturally they are more useful than plants without such value.

Poisonous Plants

Some plants may be poisonous to human beings or to stock. Great caution should be exercised in their planting.

Plants poisonous to man include those which—

(1) produce dermatitic irritations, as poison oak, ivy, and sumac;

(2) are provided with stinging hairs;

(3) are poisonous if taken internally.

Plants of classes (1) and (2) should never be planted because of their effects on planters as well as landowners. Plants of class (3) may be planted if the sites are sufficiently removed from habitations. Common sense and caution should be liberally used in planting such species. Substitutes may usually be more profitably employed.

The subject of stock-poisoning has been admirably treated by Chestnut and Wilcox ('01) and by Marsh ('29). We can do no better than to paraphrase their authoritative generalizations here.

It may be stated as a general fact that the popular idea that range animals will voluntarily seek out poisonous plants and eat them from preference, is not true. Animals seldom eat poisonous plants except when they are driven to do so by lack of other food. Almost all poisonous plants are distasteful to livestock and under ordinary circumstances will be avoided. Loco plants (Astragalus spp.) are an exception to this rule.

The state of the local vegetation as affected by weather conditions ordinarily exercises considerable influence on the occurrence or non-occurrence of poisoning. In the early spring certain plosonous plants may start to grow before the native grasses. If these poisonous plants are at all conspicuous or offer any considerable amount of succulent material, stock may be tempted to eat them. The acrid, bitter, or otherwise disagreeable taste of such plants seems to mean little to stock. Sheep and cattle may often eat large quantities of plants which are extremely unpalatable to the human taste.

In seasons of unusual drought the native grasses on the range usually mature early in the season, and may become thoroughly dried while a number of other plants frequently remain green and tempting. It is obvious that stock will be more apt to eat poisonous plants when such plants offer more tempting forage than the grasses. The converse of this statement is also obviously clear that when grasses and other harmless forage plants are present in abundance and in good condition, sheep and cattle less often make the mistake of eating poisonous plants.

To prevent poisoning of stock, reliance should be placed not on remedies but on prevention. Animals must be so well cared for that they will not be tempted to eat poisonous plants. They must be prevented from eating such plants by careful handling of the herds, it being remembered always that animals are not likely to eat poisonous plants by preference, but that under starvation conditions they may be driven to the use of such material for forage, with disastrous results.

In most instances in selecting stock for erosion control, non-toxic species can be chosen. Rarely, however, certain forms may be the only ones capable of doing the

job. In such event, great care should be exercised to see that plantings will not be available to stock. This can be accomplished either by fencing, or proper management of the herd. Consultation with the landowner goes almost without saying.

NITROGEN-FIXING, BACTERIA OF LEGUMES AND NON-LEGUMES

Many persons engaged in planting for erosion control have very wisely chosen species which are enabled, by means of a symbiotic relationship with *Bacillus radicicola*, to enrich the soil through the addition of certain nitrogen compounds to the substratum. With few exceptions, those plants belong to the Leguminosae. Because the soils left after considerable washing has taken place are often poor and unproductive, the incorporation of nitrogen is no small feature in their reclamation and stabilization. Lespedezas, alfalfa, vetch, clover, acacias, locust, honey locust, Scotch broom, and Kentucky coffee tree are legumes and have been advocated for use on the particular account of their root associations with nitrogen-fixing bacteria (nodules).

The annual decay of the root nodules housing the bacteria results in the addition of nitrogen compounds to the soil. This is true of vetch, peas, beans, clover and other annual plants or those on which nodules are produced each spring to develop through the season and decay in autumn. In black locust (*Robinia*), *Sophora*, some species of *Acacia*, and others, however, the nodules may last for more than one growing period and often become woody. Part of the time during the life of the nodules the nitrogenous compounds are used by the plant.

It should be of interest to note that not only do members of the Leguminosae form these symbiotic relationships, but also that they are formed by shrubs and trees of the genera *Alnus*, *Ceanothus*, *Elaeagnus*, *Sheperdia*, and *Myrica*, besides members of the Cycadaceae and Podocarpaceae. Members of the latter two families will, of course, scarcely be used for erosion control in the United States.

The nodules formed in non-leguminous plant roots are caused also by *Bacillus radicicola*, as cross-inoculation of legumes with strains from *Alnus* and *Elaeagnus*, has helped to prove. Although cross-inoculation of the bacteria has been successfully accomplished, ordinarily certain strains or races are specific for the host plant species. Inoculation of planting sites with the proper bacterium is an established farm practice.

In general, plants producing such nodules are able to live in very poor soils, since lack of nitrogen is not as great a factor in their success as it may be in other plants. For this reason the leguminous plants are particularly satisfactory for planting on poor, eroded land, the soil of which will, with difficulty, support other plants. Many of the legumes are not as successful on acid soils as on neutral or alkaline ones, but this is not always true, as in *Lupinus*.

In addition to the legumes, and *Alnus*, *Ceanothus*, *Myrica*, etc., certain fungi growing on roots (mycorrhiza) have been reported as fixing nitrogen. Mycorrhiza of forest trees, such as *Pinus sylvestris*, seem from many reports to be able to fix nitrogen. Even wheat and barley are claimed to do so but the work is as yet not accepted.

PROGRESS OF SCIENCE IN INDIA

In the course of his address welcoming the delegates to the Joint Session of the Scientific Societies held at Bangalore (10th-14th April), Sir C. V. Raman, KT., F.R.S., N.L., pointed to three ideals which should guide research workers to secure for India a prominent place in the scientific map of the world. A fastidious attention to a high standard of quality in scientific research constitutes the first ideal; weeds shall have no place in the garden of science and, to ensure a steady and wholesome growth and development, the weeds must be scrupulously kept out. The second ideal is to recognise the essential unity of knowledge. Science should not be conceived in terms of water-tight compartments even as a matter of administrative expediency. Administrative separatism leads to intellectual separatism and eliminates that essential factor which makes for intellectual co-operation among scientists pursuing different branches of knowledge, a co-operation which is necessary for the fruitful progress of science. Many of the outstanding discoveries have been made in laboratories which have stood for such an ideal, and where several scientific subjects are studied in close juxtaposition. To cite one instance the discovery by von Laue, of the diffraction of X-rays, was made possible in the favourable environment provided by the Munich Laboratory where such stalwarts like Prof. Sommerfeld, the eminent mathematical physicist, and Prof. Granz, the famous mineralogist and crystallographer, were working. Lastly, it is necessary to recognise the leadership which mathematical thought possesses in the progress of science. It is utterly futile to evaluate science on the gold standard. There is an amazing contempt for scientific work which does not bring an immediate monetary return. "With all the emphasis I can command, I sound a note of warning of the dangers of this attitude," said Sir C. V. Raman. "The deeper and fundamental aspects of science appeal to but a few who possess a disciplined attitude of mind. No progress can be achieved in any branch of science if we lose our respect for, or withhold support to, the fundamental sciences of Mathematics and Philosophy; the more we neglect these the less we advance." Research not founded on fundamental mathematical concepts, is like food devoid of vitamin, that entity which makes all the difference between calories and nutriment.—*Current Science*, April 1936.

THREATENING FOREST RANGER IN RAILWAY CARRIAGE

Orders have been passed by U Tin, Sub-divisional Special Power Magistrate, Shwebo, in a case instituted by the Forest Department, Burma, which had attracted attention not only in Shwebo District but in other parts of Upper Burma. The accused in the case was Maung Htwa, and the complainant, Mr. F. G. Burgess, Divisional Forest Officer, Shwebo, on behalf of U Ba Tso, Forest Ranger, attached to the Thaw Range.

It was alleged in the charge against Maung Htwa that on Septemebr 10th, 1935, while the accused, Maung Ba Tso, Mr. Herbert Fisher, an advocate of Mandalay, and

a Mr. Thompson were travelling in a second class railway carriage from Kyaikthin to Kanbalu the accused threatend U Ba Tso, but not until the train had left Pintha, at which station Mr. Thompson had got down. The accused is alleged to have told U Ba Tso that he wanted him to take leave or to get transferred from Thaw Range as he was in his way, and as long as he lived in the range, he would be his (accused's) enemy. Accused claimed to be a friend of the Forest Minister, and claimed that the Forest Minister would do as he asked. Accused also claimed that the thugyi of the tract and the villagers were his followers and that he could make them do as he liked and they would give Maung Ba Tso trouble. If Ba Tso did not go on leave as he demanded, he would bring it about that Ba Tso would be dismissed or transferred.

Matter Reported

On reaching Kanbalu Ba Tso made a report to Mr. Burgess, Divisional Forest Officer, Shwebo, who was on tour in Kanbalu at the time. He questioned Mr. Fisher and, hearing his statement, reported the matter to the Government, which ordered him to prosecute U Htwa for threatening a public servant with the intention of causing him to refrain from carrying out his duties.

The case was accordingly instituted and was taken up by Mr. A. W. Breakey, I.C.S., Sub-divisional Officer, at that time in Shwebo, but before he could complete the hearing, he was transferred from Shwebo. Then the illness of the accused caused a long postponement.

After hearing Maung Ba Tso and Mr. Fisher, who corroborated him, as to what U Htwa had said in the railway carriage, and the other prosecution witnesses, including Mr. Burgess, the Magistrate called on U Htwa for his defence. It was a denial of the charge.

Loss of Saw Mill

During the course of the trial evidence was adduced that U Htwa had lost a saw mill at Kyauktan by fire, and he accused Maung Ba Tso of being responsible for the fire and the destruction of the mill. He had also made a number of charges from time to time to the Divisional Forest Officer implying that Maung Ba Tso was his enemy and was working against him.

Mr. Burgess gave testimony to the effect that the charges made by the accused against Maung Ba Tso had been investigated departmentally and Maung Ba Tso exonerated, which had led the accused still further to write to the Department and reiterate his charges and demand the transfer or dismissal of Maung Ba Tso. The demands were refused.

The Magistrate after going at length into the evidence for the prosecution and the defence arrived at the following finding:

"I find the accused Maung Htwa guilty of the offence charged under Section 189 I.P.C. I direct that he do pay a fine of Rs. 300 or, in default, do suffer six months' rigorous imprisonment."

The fine was paid.—(*Rangoon Gazette*, 1st October 1936.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for November 1936:

IMPORTS

ARTICLES	MONTH OF NOVEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER Teakwood— Siam ..	292	24	64	33,567	2,458	6,789
French Indo-China ..	..	..	498	..	..	46,400
Other countries ..	..		286	89	..	29,127
Total ..	292	24	848	33,656	2,458	82,316
Hardwoods other than teak ..	..	..	..	..	..	..
Softwoods ..	821	1,128	641	50,803	68,694	35,158
Matchwoods ..	..	..	1,282	..	..	76,533
Unspecified (Value) ..	..	..	..	1,29,526	1,57,794	18,377
Firewood ..	81	34	71	1,218	459	1,065
Sandalwood ..	36	17	41	12,612	6,997	11,344
Total value of wood and timber ..	..	..	..	2,27,815	2,36,402	2,24,793
Manufactures of wood and timber— Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	242	..	..	63,283
Tea chests (Value) ..	..	..	..	3,90,118	4,39,834	3,80,462
Other manufactures of wood (Value) ..	..	..	..	1,79,760	2,15,898	1,13,604
Total value of manufactures of wood and timber ..	..	..	..	5,69,878	6,55,732	5,57,349
Other products of wood and timber— Wood pulp ..	44,931	18,064	20,963	3,01,665	1,20,417	1,42,178

IMPORTS

ARTICLES	EIGHT MONTHS, 1ST APRIL TO 30TH NOVEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER Teakwood— Siam ..	3,403	241	799	3,59,507	22,872	1,01,527
French Indo-China ..	2,998	425	2,408	2,47,677	49,479	2,43,149
Other countries ..	..	148	828	89	14,965	95,632
Total ..	6,401	814	4,035	6,07,273	87,316	4,40,308
Hardwoods other than teak ..	..	..	..	..	..	..
Softwoods ..	7,178	7,727	11,518	4,69,662	4,73,812	6,92,661
Matchwoods ..	..	..	7,350	..	..	4,06,038
Unspecified (Value) ..	..	..	..	9,21,903	11,88,196	2,36,616
Firewood ..	505	378	266	11,560	5,627	3,978
Sandalwood ..	251	180	207	78,748	65,925	62,673
Total value of wood and timber ..	..	..	..	20,92,146	18,20,876	18,42,274
Manufactures of wood and timber— Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	1,946	..	..	4,54,469
Tea chests(Value) ..	..	..	..	27,01,291	33,51,279	29,24,456
Other manufactures of wood (Value) ..	..	..	..	13,64,894	16,61,415	9,63,620
Total value of manufactures of wood and timber ..	..	..	..	40,66,185	50,12,694	43,42,545
Other products of wood and timber— Wood pulp ..	2,90,667	2,18,168	1,43,950	19,44,945	14,40,116	9,36,551

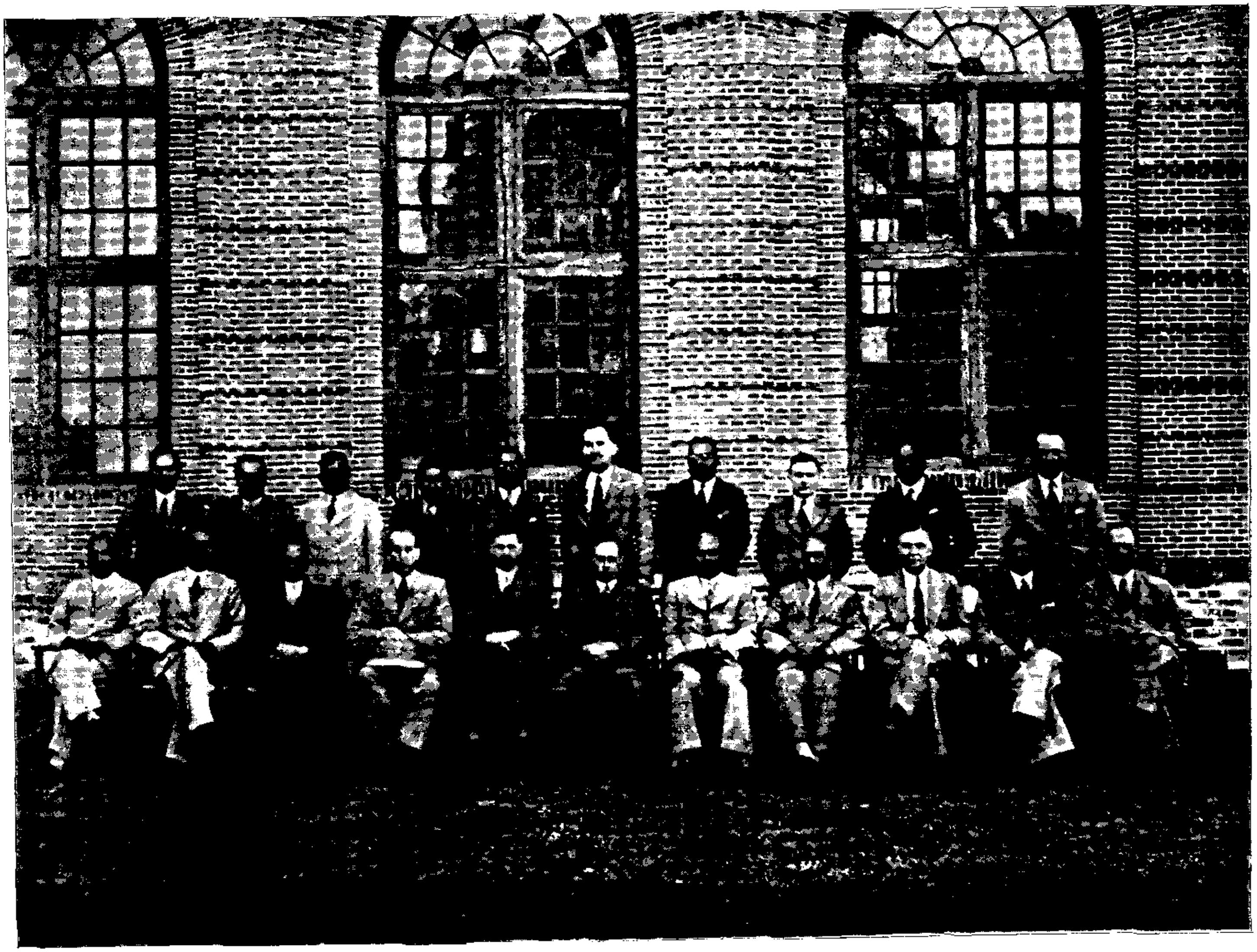
EXPORTS

ARTICLES	MONTH OF NOVEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	1,622	2,621	4,659	3,34,422	5,08,799	9,64,915
,, Germany ..	48	255	182	10,572	54,009	47,316
,, Belgium ..	..	72	..	..	17,450	..
,, Iraq ..	43	35	49	8,061	7,934	12,201
,, Ceylon ..	185	199	220	36,529	35,112	39,026
,, Union of South Africa ..	76	225	353	11,698	37,663	68,269
,, Portuguese East Africa ..	..	183	288	..	31,228	49,214
,, United States of America ..	106	40	38	31,783	10,134	10,331
,, Other countries ..	242	370	351	48,642	71,885	72,842
Total ..	2,322	4,000	6,140	4,81,707	7,74,214	12,64,117
Teak keys (tons) ..	223	406	147	33,525	60,900	17,107
Hardwoods other than teak ..	40	95	92	3,662	13,542	8,934
Unspecified (Value) ..	..	..	..	26,252	31,074	59,107
Firewood ..	131	..	..	2,397	..	..
Sandalwood—						
To United Kingdom ..	1	..	2	250	..	1,600
,, China (excluding Hong-Kong) ..	..	17	..	..	23,790	..
,, Japan ..	12	5	10	11,012	6,000	12,000
,, Anglo-Egyptian Sudan ..	7	16	11	8,625	23,245	12,235
,, United States of America ..	25	101	50	30,000	1,00 810	60,000
,, Other countries ..	..	4	2	1,019	5,590	2,546
Total ..	45	143	75	50,906	1,59,435	88,381
Total value of wood and timber ..	..	..	..	5,98,449	10,39,165	14,37,646
Manufactures of wood and timber—						
Furniture and cabinet-ware ..	No data.			No data.		
Other manufactures (Value) ..	..	..	..	6,186	9,035	18,350
Total value of manufactures of wood and timber ..	..	..	..	6,186	9,035	18,350
Other products of wood and timber ..	No data.			No data.		

EXPORTS

ARTICLES	EIGHT MONTHS, 1ST APRIL TO 30TH NOVEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	17,608	22,341	28,784	38,97,439	43,46,727	59,44,805
,, Germany ..	1,309	3,634	2,912	3,21,124	8,40,373	6,99,663
,, Belgium ..	243	702	223	48,635	1,35,099	35,215
,, Iraq ..	654	761	405	1,32,088	1,39,088	78,764
,, Ceylon ..	503	715	879	72,990	99,486	1,30,888
,, Union of South Africa	2,149	2,294	4,016	4,84,924	3,80,303	8,11,646
,, Portuguese East Africa ..	173	870	1,300	28,545	1,50,443	2,20,676
,, United States of America ..	401	313	373	1,18,637	76,628	1,08,361
,, Other countries ..	2,693	3,133	3,874	4,98,171	5,89,581	8,44,436
Total ..	25,743	34,763	42,766	56,02,553	67,57,728	88,74,504
Teak keys ..	2,325	3,073	2,441	3,30,494	4,52,627	3,43,130
Hardwoods other than teak ..	570	576	1,141	56,991	63,690	1,18,738
Unspecified (Value) ..	..	..	..	1,87,071	2,47,666	3,86,755
Firewood ..	132	29	..	2,403	436	..
Sandalwood—						
To United Kingdom ..	31	12	7	38,936	14,560	6,800
,, China (excluding Hong-Kong) ..	36	25	59	58,685	35,490	71,560
,, Japan ..	40	71	56	43,669	77,399	1,10,631
,, Anglo-Egyptian Sudan ..	36	55	54	39,300	69,090	62,535
,, United States of America ..	288	325	338	3,38,800	3,28,290	3,74,948
,, Other countries ..	14	32	39	27,035	38,411	52,627
Total ..	445	520	553	5,46,475	5,63,240	6,79,101
Total value of wood and timber—	..	..	..	67,25,987	80,85,387	1,04,02,228
Manufactures of wood and timber—						
Furniture and cabinet-ware ..	No data.			No data.		
Other manufactures (Value) ..	..	..	..	84,939	66,401	83,262
Total value of manufactures of wood and timber ..	..	..	..	84,939	66,401	83,262
Other products of wood and timber ..	No data.			No data.		

THE FOREST UTILISATION CONFERENCE, DEHRA DUN, 1937



Standing (left to right).—S. N. Kapur (F. R. I.); Mohsin Bin Mohammed (Hyderabad State); S. Kamesam (F. R. I.); Amir Chand (Kashmir), M. P. Bhargava (F. R. I.); E. A. Garland (Bombay); K. A. Chowdhury (F. R. I.); W. D. M. Warren (Bihar); J. Singh (Punjab); D. Stewart (U. P.).

Sitting (left to right).—Sasi Mohan Deb (Assam); L. R. Sabharwal (F. R. I.); N. Menon (Cochin); H. Trotter (F. R. I.); F. Canning, C.I.E. (U.P.); Sir Gerald Trevor, C.I.E., Inspector-General of Forests; C. Abdul Jabbar (Mysore); Muhammad Abdul Hafiz Sahib (Madras); C. T. Trigg (Bengal); Mohd. Abdus Salam (C. P.); G. D. Kitchingman (N. W. F. P.).

INDIAN FORESTER

MAY, 1937.

FOREST UTILISATION CONFERENCE HELD AT DEHRA DUN FROM THE 17TH TO 20TH MARCH 1937.

OPENING SPEECH OF SIR GERALD TREVOR, C.I.E., INSPECTOR-GENERAL OF FORESTS.

GENTLEMEN,

My first duty this morning is to give you a very hearty welcome both on my own behalf and on behalf of the officers of the Forest Research Institute. We are all very pleased to see you here and I can assure you that we will do our utmost to answer any questions and to supply any information which we may have at our disposal.

The functions of the Forest Research Institute are to assist you, gentlemen, in improving your marketing facilities, in finding further outlets for forest produce and generally for increasing forest trade in India. In the past we have been able to do something in this way. You know perfectly well that the paper pulp industry was organised by Mr. W. Raitt, late of the Forest Research Institute, and at the present moment most of the printing and writing paper is manufactured out of bamboos. While we are only too willing to assist you, gentlemen, in improving forest revenues, it is the duty of forest officers in provinces to do their utmost to make use of the work done at Dehra Dun and of the results of the researches which we have carried out. I do not propose to make a long speech, but in opening this Conference I want to say a few words about the various activities of the Forest Research Institute in the way of timber and the utilisation of forest produce.

For many years past Mr. W. Nagle of this Institute has been working on plywood, samples of which we have in this room. The possibilities of Indian plywood are very great. You have only to look round these walls to see what can be done with *Terminalia*

tomentosa or Indian laurel, a timber which has already secured a market in London. So far in spite of all the work we have done nobody has come forward to undertake the manufacture of this line in India, but I am very glad to tell you this morning that our efforts have been rewarded and we have got a firm ready to manufacture high-class panels in Calcutta. When this comes about you should be able to dispose of any ornamental timber, which you, gentlemen, may have to sell.

We hope to extend the use of timber in engineering construction, but with that is bound up the question of the preservation of wood. It is no good advocating further use of wood in Indian engineering construction unless we provide a remedy against white-ants, fungi and general decay. You have no doubt heard of Ascu which was worked out by Mr. Kamesam and of the controversy which has arisen over this preservative. I do not propose to enter into this controversy but I can say that Ascu has given very satisfactory results. If you will take the trouble of examining specimens on the table treated with Ascu you will find that they are quitesatisfactory. Another matter is that we now have designed a plant which costs a comparatively small sum of money in which this treating can be done. You know perfectly well that a creosote treating plant is a matter of great expenditure. The plant that we have designed for Ascu is simple and the whole cost of this plant is comparatively small and it can be carried anywhere in India. That itself is a great advantage.

We have also endeavoured to push the use of timber at the Lucknow Exhibition. The house was constructed of timber treated with Ascu by Messrs. Callenders, who are the commercial agents of Ascu. When I come to wooden houses I would ask you to glance over the publications and the great efforts which are being made in other countries to extend the use of timber. We hope to do something in this nature in the Timber Development Branch.

Another item on which we have done a certain amount of work is wooden electric transmission poles. You are all aware that at the present moment the price of steel poles is rising and the price has already risen by 20 per cent. and it may be difficult to obtain them at an

economical price. There is therefore much advantage in pushing the sale of wooden poles at this moment. It is no good to say that wooden poles are not available. Sufficient supplies of the poles can be obtained by taking a little trouble. I have seen the most excellent sal poles which were carefully picked over for this purpose. Gentlemen, I should like to make it perfectly clear to you, if this business is to be a success you must select a high quality of wooden pole for this purpose. The price is there, the pole is there, but a little organisation is required. I would ask anybody interested in this pole market to meet Mr. Whitmore of Messrs. Callendars to discuss the matter. He will give a demonstration at Dehra Dun of the method of treating transmission poles, if a sufficient number of delegates would like to attend such a demonstration. One thing I am certain of, and that is if this business of poles is to be carried through in a satisfactory manner it will be necessary for somebody to keep stocks of treated poles. Either Messrs. Callendars or some other firm or the Forest Department will have to keep suitable stocks of treated wooden poles. The Forest Department must have six months or nine months notice before they can supply poles and the only way in which this trade will flourish is by some one keeping suitable stocks of well-graded and well-seasoned treated poles.

Another matter on which we have worked here for sometime past is seasoning, and particularly the cost of seasoning. You will have an opportunity of seeing for yourselves our new smoke kiln which we have devised at a cost of Rs. 2,000 to Rs. 2,500 and which has given satisfactory results. We do not profess for one moment that it is perfect, we have not yet published much about it, but we certainly think we have obtained a satisfactory means of seasoning timber at a cost of about 6 annas per c. ft.

I have asked the Government of India to start a Timber Development Section of this Institute dealing not so much with the research but with the extended use of timber in engineering, in negotiating with the railways for the reduction of freight and putting treated timber before the public in India. I am not very fond of propaganda, but it seems to be the order of the day. One of the matters I would

like to discuss is how can we succeed in extending the use of timber against the competition of concrete and steel. There is another matter in which I think much good can be done and that is co-operation between various provinces in discussing the prices of timber and general sales policy. This chiefly affects those provinces whose market is Calcutta. I think it would be a good thing if the Forest Utilisation Officers of these provinces were to meet annually to discuss the problem of sales policy and the problem of disposing of their forest produce. At present, you are competing one against the other.

Finally there is the question of grading timber. Mr. Seaman, after a great deal of work, prepared rules for grading teak squares for the Indian market. Formerly the teak firms of Burma used to sell teak squares under their own private marks. What these marks meant nobody else knew. We have, at the request of the Railway Board, brought out these Standard Grading Rules for teak squares. The great advantage of these rules is that you can supply your timber to the railway graded according to the rules and the grading can only be challenged by going to arbitration in which case the loser pays the costs. Undoubtedly timber in India has suffered from lack of grading. I think there is a possibility of extending the question of grading various classes of timber in India and we here at the F. R. I. will be glad of advice on this subject. This, gentlemen, concludes what I have to say and we will now get on with the business on the agenda which you have before you.

RECLAMATION IN THE PABBI HILLS, GUJRAT DISTRICT, PUNJAB

BY R. MACLAGAN GORRIE, D.SC.

Summary.—The Pabbi Hills are a deeply eroded line of low foothills in the north-west corner of Gujrat District, Punjab, with arid conditions and a precarious rainfall of a few heavy thunderstorms each monsoon. The range is 30 miles long and exhibits all stages of grazing damage between long-continued closure and persistent overgrazing. The run-off in terms of maximum peak flood has been measured by the Irrigation Branch during the last 30 years for a great many individual torrents, and the records thus obtained have been correlated with catchment conditions. The results show clearly the value of constructive counter-erosion work to supplement passive protection against grazing.

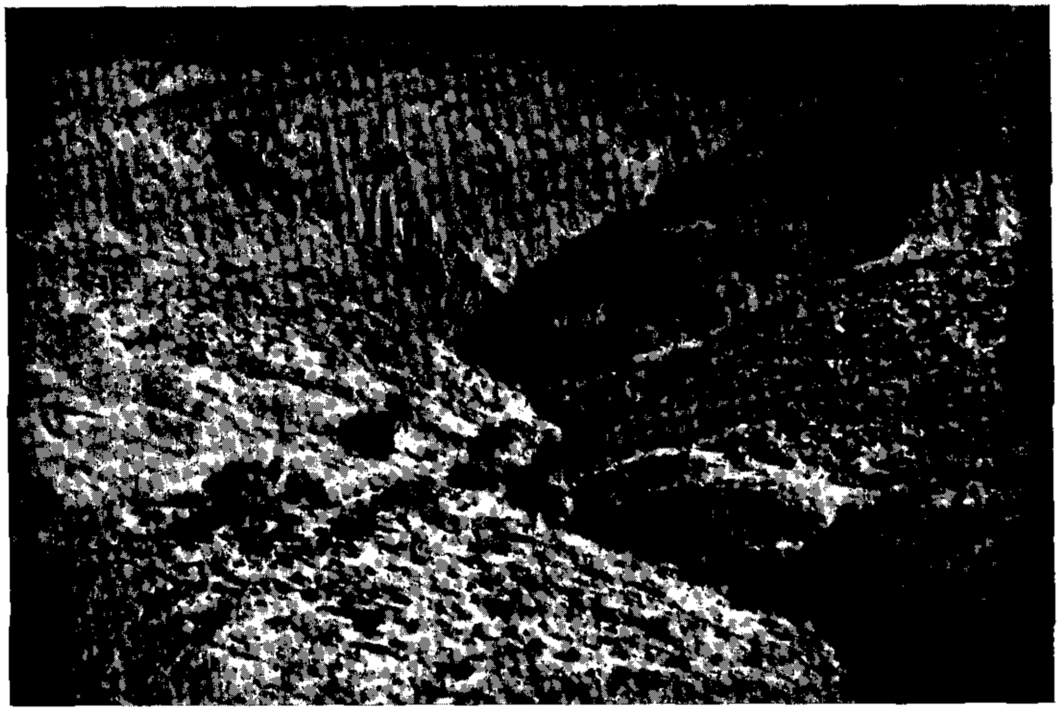
An historical account is given of the reclamation work which has been carried on intermittently since 1877 and is now effectively controlling run-off over 3,000 acres. Suggestions for future work include stricter grazing control over the whole "reserved forest," land acquisition and eviction of graziers from land not yet reserved, "gully plugging" in torrent headwaters to reduce flood peaks, improvement of natural grass crops by contour trenching and afforestation with *Prosopis glandulosa* and *Acacia modesta;* also improvement of farm cultivation by stream training and contour terracing.

An impression of the Pabbies and their problem.—For the railway traveller on the North West line, or the luckier individual speeding in a motor along the Grand Trunk Road towards Rawalpindi, the first hint of the mountains beyond is to be found between the Chenab and Jhelum rivers, when the monotonous flatness of the plains gives way to the ridges and ravines of the Pabbi hills. In truth, these are hardly worthy of the name of hills, for they are a mere introduction to the Himalayan foothills. They are a No Man's Land, a desert of tumbled ravines of bare earth, a geological rubbish dump, where no man lives by choice and few come for profit. There one gets the impression that this long-suffering world of ours has gone bad, just like a rotten tomato ; and just as a rotten tomato would be seized upon by ants and all the other scavengers, so is this countryside being rapidly carried off towards the plains and the sea by every rain-storm that happens.

Originally this was a plateau of high savannah land, but gradually the tree growth was destroyed and the superficial stratum of sandstone was eaten away by the processes of natural erosion. Below it lay beds of yellow sand and a red clay shale which had no cohesion whatever,

and on these the torrential rains of the monsoon could now work their violent will. Thus it is that to-day the area is honeycombed with ravines, some of them nearly three hundred feet deep, which have been gouged out by water action, and the bare earth towers upwards in incongruous cliffs and ill-balanced screes, while the work of destruction is going on apace. Each monsoon carries off its quota of millions of tons of silt and sand, some of it to the cultivators' fields below, some of it to silt up the river beds or to handicap the canal irrigation work. Already this menace of erosion from the Pabbi alone has cost the country many lakhs of rupees, in the innumerable sluices and syphons which were necessary to allow each torrent to get clear of the Upper Jhelum canal bed, in the many culverts and masonry bunds on the North Western Railway line for the same purpose, in the loss of revenue from the grazing lands which have been washed away, and in the damage done by the torrential floods which rush over the zamindari lands below, carrying in their train a load of infertile clay and sand. A further menace which is making itself increasingly evident, particularly on the Chenab side, is that this ravining process is actually extending outwards into the farm lands, and many zamindars are helplessly watching their flat and prosperous fields being gouged out into ravines and gullies which in a couple of monsoon seasons may render ploughing impossible.

2. *Historical sketch of reclamation work.*—There is little information about this desolate tract prior to 1857 when it was taken over by the British administration, but it is probable that at one time it carried a reasonably good cover of scrub jungle. About 1877 attempts were made to regulate the grazing and the whole of the central ridge, approximately 30 miles long by 3 miles across, was constituted a reserved forest with an area of 39,000 acres. In the middle of this a small area near Bani and astride the North Western Railway line and the parallel Grand Trunk Road, was taken up for active reclamation work with the immediate object of protecting these works. In the early 1880's this work was energetically pursued by J. H. Lace, a most capable forest administrator and a very fine botanist. This work attempted to control the sudden run-off and restore a vegetation cover



EACH SMALL BRANCH OF THIS DEEP NALA IS CUTTING BACK RAPIDLY INTO THE UNPROTECTED SLOPES FROM WHICH PERSISTENT GRAZING HAS DRIVEN OUT ALL BUT THE HARDIEST REMNANTS OF THE PREVIOUS SCRUB-JUNGLE COVER. THIS IS TYPICAL OF MUCH OF THE PABBI AND SALT RANGE COUNTRY

Photo : R. M. Gorrie.

THE DOWNSTREAM SIDE OF AN EARTH BUND IN THE RECLAMATION AREA. THE BUND IS NOW WELL REVETTED WITH A MASS OF TREE ROOTS AND PRACTICALLY NO FLOOD WATER PASSES BELOW, AS CAN BE SEEN FROM THE GRASSY CHANNEL BED IN THE FOREGROUND

Photo : R. M. Gorrie.

by the following means:

(*a*) Trenching dug along the contours of steep slopes to catch and hold water for the use of tree seedlings on the berm. Trenches towards the bottom of the slope were dug deeper to catch a large amount of water and so prevent gullying by the accumulated drainage.

(*b*) Bunds of loose stones built up in low retaining walls or sills across nala channels to spread out the flowing water and prevent it cutting deeper into the soft strata below.

(*c*) Ploughing and broadcast sowing on all flatter surfaces and plateau lands.

(*d*) The tree species tried included *Acacia arabica* and *modesta*, *Dalbergia sissoo*, *Dodonaea viscosa* and willow cuttings.

That this work was done on an extensive scale is shown by the records. For instance, in 1883, 270 new bunds were built and 5,425 bunds repaired. This was continued regularly till 1888 when 700 acres had been reclaimed; unfortunately the work was then allowed to lapse. The exact location of this original work is not known, but one is constantly meeting traces of Lace's stone bunds which have stood up wonderfully to the test of time. Of the many species tried, only the indigenous phulai (*Acacia modesta*) and the Mexican mesquite (*Prosopis glandulosa*) have persisted. The former is a local species and very slow-growing. The mesquite is faster in growth, has become completely acclimatised and is the only tree species which has since regenerated at all freely; its original introduction probably dates from seed brought from Kew in 1877. but at one time it was written off as a complete failure.

The subsequent history is a rather depressing repetition of periods of constructive work and neglect, marked by a pendulum-like oscillation of the administrative mind between the commercial and the beneficent sides of forestry activities. The following extracts from Conservators' reports will bring this out most clearly:

Elliot in 1896 writes: "It is unfortunate that the cultural operations as carried out for several years have been discontinued for

the last five or six years; apparently since 1890 nothing has been done and for two or three years the work was done in a half-hearted sort of way. It may be said that nothing worth mentioning has been done since 1888 when apparently operations were stopped by orders of the Conservator. I have inspected the reboisement work and am of opinion it is as successful as could be expected and that it certainly should be continued. One has only to get up to a fairly high point and to look over the country to see the marked distinction between the area operated on and that left untouched." Again in 1898 he writes: "On the 10th instant Mr. Ribbentrop inspected the area with me. The Inspector-General of Forests recollects the area when it was first taken in hand and was struck by the way in which the ridges have broken down, *e.g.*, where a path went along a ridge just below the old forest Rest House there is now nothing but broken peaks and no trace of the path even. The work to be done is the continuation of the former efforts, but more in the direction of stopping the erosion of the valleys than by plantations on the higher ground. Small walls, or even layers of stone should be made across the drainage cuts, taking up one or two valleys at a time."

Little was done from 1898 till 1909 apart from maintenance, and in the latter year C. P. Fisher wrote: "The question then resolves itself into this: Is it worth spending some Rs. 1,500 a year or more in order (*a*) to save the neighbouring cultivation from destruction by the detritus resulting from denudation and (*b*) in order to keep the area afforested? As regards the first point I doubt very much whether the danger of the destruction of cultivated lands has not been over-estimated. I have not seen enough of the country to feel certain of the correctness of my assumption, but what I have seen justifies it. Moreover, an examination of the 4" map shows that the streams running south-east and north-west have very short courses inside the hills and very small catchment areas, so that the volume of water they carry to the plains is but small and the detritus cannot be very much. As regards the second point it is undoubtedly desirable to keep the area afforested from all points of view, but I do not think, subject to the point I have noticed above, that it is worth paying

PART OF THE PABBI RECLAMATION AREA, SHOWING GOOD GROWTH OF MESQUITE AND PHULAI TREES. IN THE FOREGROUND IS AN *OLD LOOSE-STONE CHECK DAM; THE MAN IS STANDING* ON TOP OF AN EARTH BUND ORIGINALLY 12 FT. HIGH, NOW COMPLETELY SILTED UP, BUT THE IMPOUNDED SILT IS SO STERILE THAT NOTHING WILL GROW ON IT

Photo : R. M. Gorrie.

THE BROAD SHALLOW CHANNEL OF SHIFTING SAND AND ERODING BANKS, TYPICAL OF THE DENUDED LAND OF THE GUJAR VILLAGES AT THE SOUTH-WEST END OF THE PABBI HILLS

over one rupee per acre per annum as we are now paying to do so." Further work was, therefore, stopped until 1913.

3. *Canal protection project.*—A new phase of the erosion problem had appeared with the building of the Upper Jhelum Canal which had to traverse the entire length of the northern flanks of the Pabbies and several miles of the southern flanks in order to reach the plains beyond. Erosion affected this canal in two ways : first, by the very heavy load of silt brought into the canal from the four biggest torrents which mingle with the original river water at "level crossings;" second, by the danger of bursting the syphons by which the smaller torrents are led under the canal bed towards lower levels. These syphons were unfortunately built in brick arch, not in concrete, so they are not able to stand any very high pressure from within such as is applied when a torrent heavily loaded with mud comes down in spate. In order to prevent them bursting the canal has to be run full throughout the monsoon season in order to keep up a pressure on the outer side of these arched syphons.

The need for improving the run-off conditions on the north face of the Pabbi was appreciated by both the irrigation and the forest departments, and in 1913 fresh areas on the north face of the range were taken up for reclamation. Work was, however, only done on a very small scale and only a few acres of reclamation work was attempted, the results of which were largely lost through failure to control illicit grazing because of the distance from the range headquarters at Kharian.

Unfortunately interest in canal protection flagged and when next funds were made available for work on a larger scale in 1921, it was resumed in the Bani neighbourhood where the improvement in run-off was not of any obvious benefit to the Irrigation Department.

The amount of silt deposited in the bed of the canal had increased so much that in 1931 it had lost 40 per cent. of its capacity. In that year four silt ejectors had to be installed at considerable expense and although these have checked further silting, the canal is still running far below its intended capacity. The heaviest load of silt comes from the Jammu foothill torrents to the north-east, but part of the blame

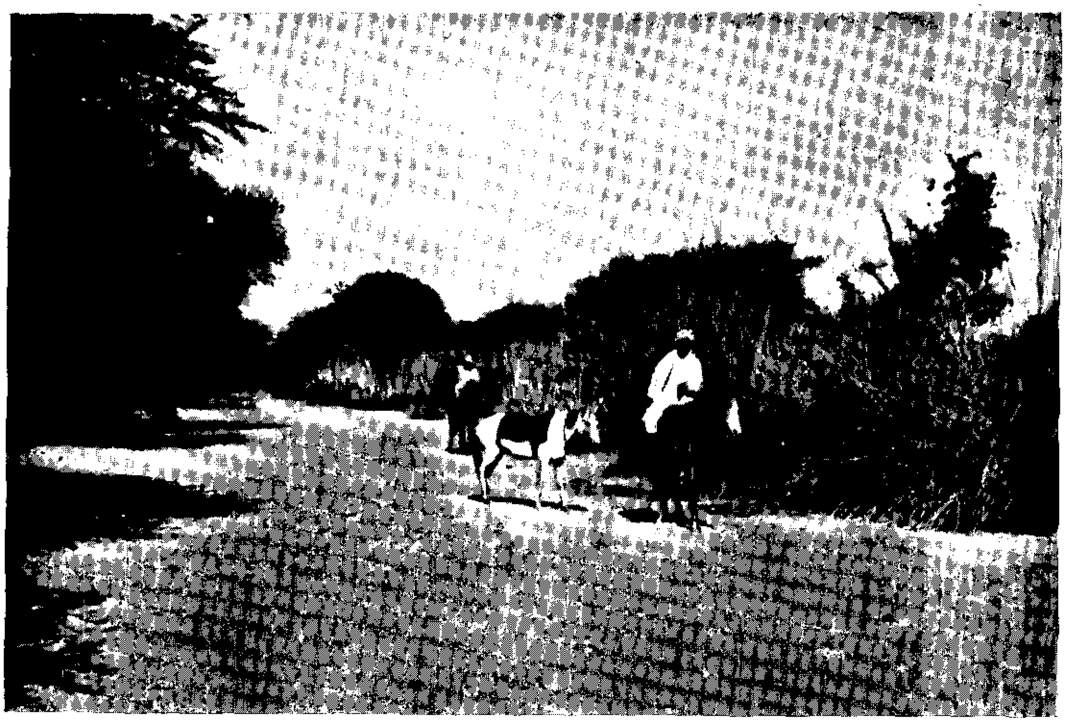
must be borne by the Pabbi torrents which contribute to the "level crossing" outlets. A further menace is the excessively heavy discharges from a group of torrents in the south-west corner of the range; these rise in gently sloping land which was unfortunately omitted from the original demarcation of the reserve and has since deteriorated through persistent over-grazing from Gujar villages until it is now a waste of shifting sand. This group of torrents is a constant source of danger owing to the very sudden floods and heavy silt load which they bring down to their syphons, six syphons from this area showing the very high maximum flood peak load of 1,600 cusecs per square mile of catchment.

4. *Recent developments.*—In 1921 E. A. Courthope based fresh work upon his previous experience of similar work in Etawah and Agra, arranging for the use of large earth bunds to dam eroding channels, instead of the smaller stone ones, which by now with higher labour rates were proving expensive. He also hoped to build up a large cut-grass reserve against famine years by ploughing and sowing grass on the level areas and plateaux.

One of the most difficult problems of earth bunds is to deal with the surplus water which, when the dam is full, tends to cut out a fresh channel through the bund itself. Several different types of channels and flumes to prevent this were tried, the most successful being an earthenware pipe set in the soil of the bund with its top end well below the level of the bund top. This led away the surplus water after the dam had filled up, but gave rise to leakages which required constant attention. Most of the bunds silted up completely within a few years and their banks have become reinforced by a mass of tree roots, but the soil caught by them is so sterile that little will grow in it. Some that have not silted completely continue to catch and hold large quantities of water. The correct role of the bund is to catch water rather than soil, so it should not be built until sheet erosion has been to some extent arrested. The earth bund moreover requires continued attention because sooner or later it is subject to fresh gullying. From this point of view it is not so dependable as the smaller and less pretentious stone bund though the earth bund undoubtedly stops and

GUJAR GRAZING GROUNDS ON THE GENTLER SLOPES OF THE PABBI SOUTH FACE, ONCE A THICK COVER OF PHULAI AND BER THORN SCRUB, BUT NOW A WASTE OF SHIFTING SAND HELD HERE AND THERE BY A MUTILATED BUSH, WITH NO GRASS WHATEVER

Photo: R. M. Gorrie.



KANA GRASS TENDING TO SPREAD IN THE NALA BED OF TRIKIWALA KAS, SHOWING THAT FLOODS ARE LESS SEVERE THAN THEY USED TO BE. THIS IS THE RESULT OF A CONTINUED REGIME OF PROTECTION AGAINST GRAZING, BUT WITH NO ACTIVE EROSION CONTROL WORK

Photo: R. M. Gorrie.

holds large quantities of silt and water. *In the Pabbi good stone is* scarce and has to be carried a long way, so that the earth bund is of undoubted value, but it must be kept under proper maintenance, particularly during the monsoon season.

The difference in climate between Etawah in the U. P. and the Pabbi accounts for the comparative failure of Courthope's attempts at grass production. The annual total rainfall of the surrounding district is about 23", not far below that of Etawah, but its distribution is much worse because storms are infrequent and come as enormously heavy and sudden bursts of rain, separated by many months of complete aridity. The rainfall in the interior of the Pabbi range is several inches below that of the country on either side and the difference is probably due to the persistent upward air currents originating from the steep ravines of bare sun-baked earth. The currents of overheated air serve to drive off approaching rain clouds, and it is a common experience to have a soaking rain at Kharian and Jhelum City, but hardly a drop in the Pabbi range between these two points. This is a well recognised phenomenon of disforested country in the more arid tropics, and adds appreciably to the difficulties of re-establishing a good plant cover. The grass crop sown on the ploughed land of the more level plateaux, mostly *dhaman (Pennisetum cenchroides)* flourished for two or three seasons, particularly under the light shade of a scattered stand of mesquite, but when the effects of ploughing became masked by the formation of a flat earth surface, the poorer local grasses such as *dab* (*Eragrostis cynosuroides*) replaced it and drove it out. The best indigenous grass, *chimber*(*Eleusineflagelligera*), persists much longer on the berms of contour trenches and under a light tree shade. It would seem, therefore, that improved grass crops can only be produced in the climatic conditions of the Pabbi under a regime of fairly deep contour trenches and partial afforestation. The reclamation area of about 3,000 acres now yields a revenue of 16 annas per acre for grass cutting as compared with a grazing revenue of 1½ annas per acre for adjoining land open to grazing; this revenue from cut grass is from areas ploughed or trenched anything up to 16 years ago and could doubtless be increased by periodic ploughing with the definite object

of improving the yield and quality of the grass. This would be justified in the more accessible areas of fairly level ground but not in the less accessible parts of the range where the aim must be to produce a reasonably good plant cover of any kind at all at the cheapest rate per acre. In these the reopening of old trenches to retain water rather than silt would be of undoubted value, though it has not been tried yet.

5. *Comparative run-off from reclaimed and eroding land.*— Since the canal was built the flood discharges of the many torrents which cross the canal at right angles have been measured, and these torrents can, therefore, be classified according to their run-off intensity in cusecs (cubic feet per second) per square mile of catchment. The worst offenders with a peak of nearly 1,600 cusecs are those draining the Gujar grazing grounds of the south face, while the figures for the north face vary directly with the intensity of grazing. Those fairly well protected average 600—700 cusecs, while those at the ends furthest from the range headquarters, and carrying considerable grazing incidence either under a recognised lease or illicitly, show about 1,000 to 1,100 cusecs. Comparative figures for nalas draining from the Reclamation Area show a run-off which seldom exceeds 100 cusecs per square mile, even in very heavy storms, while in the sandy outflow channels, where these streams reach the lower more level ground, a considerable area of cultivation has been reclaimed from the waste. The striking point about these reclaimed fields is that they remain in cultivation close up to the edge of a very narrow stream bed, whereas the unreclaimed torrent outflows have anything up to half a mile width left uncultivated owing to the danger and damage of their sudden flood peaks. This in itself demonstrates clearly the advantage of controlled run-off and would justify a considerable outlay on reclamation work in the hilly catchments of all these torrents apart altogether from improving the canal regime.

Of the four large torrents which are provided with a "level crossing" sluice to allow flood water to cross the canal bed, unfortunately only one, the Jaba Khas, is in British territory and the other three are in the Bhimbar and Mirpur *ilaqas* of Kashmir State. This

THE OUTFLOW CHANNEL BELOW THE HILLS IN THE GUJAR GRAZING SECTION. THE *dhak* TREES IN THE FOREGROUND MARK THE EARLIER BANK, NOW ERODED SOME 40 FEET TO THE LEFT. COMPARE THIS WITH THE TRIKIWALA KAS WHERE THE INVASION OF KANA GRASS MARKS A REDUCTION IN FLOOD INTENSITY

Photo : R. M. Gorrie.

EFFICIENT TERRACING CAN WORK MARVELS IN SAVING SOIL EROSION AND REDUCING RUNOFF TO A NEGLIGIBLE QUANTITY EVEN IN SEVERE STORMS

Photo : R. M. Gorrie.

Jaba Khas has a catchment of 62 square miles, about one-tenth of which is in Kashmir, another tenth is the northern flank of the Pabbi Reserve Forest; of the rest half is exceedingly broken cultivation with terraced fields which vary in the efficiency of their terracing, and the uncultivated remainder is under uncontrolled grazing and eroding fast. The maximum discharge registered for these 62 square miles is 56,600 cusecs—an intensity of 915 cusecs per square mile. To give some conception of the amount of silt carried by these streams, I quote the Irrigation Department's figures* for two floods of the 1936 monsoon caused by rainfalls of 3·70 and 2·70 inches:

Volume of flood.	Total silt content.	Silt content coarser than 0·075 m. m. diam.	Silt carried in one hour.	
			Total.	Coarse.
Cusecs.	Per cent.	Per cent.	Tons.	Tons.
11,200	1·15	0·18	23,000	3,600
27,750	*2·04*	*0·30*	*102,000*	*15,000*

These figures show how rapidly the carriage of silt increases with the intensity of the run-off. Out of the total silt carried, a great deal is fine colloidal material which is carried clear away to irrigated fields or straight to the sea. Out of the remainder, however, there is sufficient to upset the carefully calculated series of canal gradients and even of the main river itself, as is seen from the way in which Jhelum City is being continually menaced by flooding, due largely to the raising of the river-bed in the neighbourhood of the city by its own persistent deposition of coarse erosion debris.

Further striking figures are given by a group of seven canal syphons carrying the drainage from a tract of country to the south-east of the

* I acknowledge with grateful thanks the help given me by Mr. E. S. Crump, C.I.E., Superintending Engineer, Upper Jhelum Canal, in supplying these figures and much other useful information about canal conditions.—R.M.G.

Pabbi range; when the canal was built this was mostly gently sloping waste land suffering from sheet erosion, the only steep ground being the south face of the Pabbi. The run-off from this area totalling 228 square miles was formerly considerable, floods prior to 1921 registering 94 cusecs per square mile. Since then, however, much of this land has been brought under properly terraced cultivation, partly through the partition to private individuals of what was formerly common grazing ground. The effect has been to reduce the run-off from this very large area to an almost negligible quantity as no floods have been recorded since then. The reclamation of three of the large south-face Pabbi torrents within the reserve probably is to a small extent responsible for this improvement, but most of the credit must go to improved cultivation methods in the terracing of waste land.

6. *Future development.*—The interest of the Irrigation Department has been enlisted afresh in a programme designed to control run-off from obvious danger points which have now been defined more clearly than before by means of the analysis of run-off intensity data. Past experience in the very trying local climatic conditions shows that any programme must include the following heads:

(1) *Control of grazing.*—Do away with all grazing in the forest reserve and substitute grass-cutting for grazing as far as possible within the reserve and in village grazing grounds.

- (*a*) A larger protective staff is required to prevent illicit grazing, particularly in the less accessible beats at the ends of the range furthest from headquarters and along the rights of way which traverse the range.
- (*b*) Land acquisition of those areas outside the present reserve which constitute danger points, notably the grazing grounds of a group of Gujar villages in the south-west.
- (*c*) Demonstration and propaganda amongst villagers for the proper maintenance and stall-feeding of smaller herds of selected animals. This is the surest way by which they can be induced to improve their animal husbandry without recourse to repressive legislation for the reduction of flocks and herds.

PABBI RECLAMATION AREA SHOWING GOOD DEVELOPMENT OF MESQUITE AND PHULAI AND A CONSIDERABLE VOLUME OF WATER CAUGHT BEHIND AN EARTH DAM WHICH IS NOT VISIBLE IN THE PICTURE

Photo : R. M. Gorrie.

(2) *Control of run-off.*—Check and delay drainage of surface water in order to give vegetation a chance of establishing itself.

(*a*) Cut down or blast down vertical cliffs of soil in the heads of nalas to a slope somewhere near the natural angle of repose, and provide diversion ditches to lead surface water off by less vulnerable routes.

(*b*) Plug V-shaped gully channels with sills of loose stone to stop cutting action of water and delay run-off. The larger sills will have to be bound in wire cages. The use of temporary check dams made of perishable material, such as brushwood and poles, is only justified in nala channels with a very gentle slope. The whole topography is so steep and broken in this arid zone that vegetation cannot by itself be expected to prevent erosion entirely, and with the rotting of temporary structures on steep gradients damage is likely to occur afresh.

(*c*) Build earth bunds with a clay core at chosen sites in the larger nala beds where a considerable quantity of water can be impounded without fear of bursting. Drop-inlet culverts or pipes must be provided to control the level of the impounded water.

(*d*) Dig contour trenches in short lengths in echelon at frequent intervals on all moderate slopes.

(*e*) Plough contour ridges on all gentle slopes.

(3) *Control of erosion.*—Encourage a better plant cover by the following means:

(*a*) Monsoon sowing of mesquite and other useful tree and shrub species along trenches and bunds.

(*b*) Monsoon transplanting of *Agave* and *Opuntia* succulents in the shade of trees already established.

(*c*) Ploughing and sowing of fodder grasses on all gentler slopes; transplanting of grass roots along bunds.

(*d*) Transplant kana grass (*Saccharum munja*) in the sandy outflows of nalas in order to check pace of stream in flood.

(4) *Improve cultivation methods by the following means :*

(*a*) By assisting zamindars to take up stream training work for the better protection of existing fields and reclamation of land now derelict owing to menace of floods.

(*b*) By encouraging a better standard of *watt-bandi*, which is the local equivalent of the American contour terracing, for trapping and holding a larger percentage of the rainfall on their fields.

THINNING PRACTICE IN CONIFEROUS FORESTS

By N. G. Pring, I.F.S.

Summary.—In the early days of forestry in the Punjab and the Frontier factors such as inaccessibility and small staff prevented thinnings on the present scale. However, some of the finest woods to-day are the result of past thinnings. The writer stresses the fact that heavier grades of intensity now practised were then not feasible. Shelterwood plans increased the area under thinnings, but the tendency to thin too lightly remained until a heavier school emerged as the result of experience. The importance of Punjab Forest Leaflets No. 1 (Trevor, 1931) and No. 2 (Glover, 1932), which have had an excellent effect on thinning practice, is stressed.

Dealing with the classification of thinnings the writer agrees with Gerrie that "C" grade has been very widely interpreted, and, in practice, frequently covers C/D to the benefit of the crops. The writer also includes paragraphs on selection forest, plantations, spacing, thinning cycle, kinds of thinnings, broad-leaved forest, research, etc., quoting well-known authorities to support his views.

Concluding he pays tribute to the work of Dehra Dun and Ghoragali trained subordinates and shows that the last decade has seen a marked tendency towards heavier thinning, evolutionary rather than revolutionary, the natural sequel to experience.

The necessity for thinnings was of course realised in the earliest days of forest conservancy in India, which is natural considering the fact that most of our early forest officers were trained in Germany or elsewhere on the Continent. The selection system was the method of treatment generally in force, but in numerous areas, which had been heavily overfelled previous to forest conservancy, improvement fellings and thinnings prescribed by area were the rule. To quote from the Simla Working Plan (Hart, 1898): "in the improvement fellings the main thing to be attended to is the removal of the malformed trees wherever these are standing over or interfering with good advance growth, or wherever they are no longer required for natural reproduction. The object of the thinnings is to promote the growth of those poles which are destined to be the mature trees of the future."

Improvement fellings were particularly necessary in the more accessible forests, because previous to the introduction of forest conservancy, contractors had removed most of the larger and better stems and had left all the malformed ones. There is no doubt that as a result of these improvement fellings our forests have greatly improved and the number of malformed trees has been greatly reduced. Needless to say the earliest contractors paid no attention to thinnings, so that when the working plans were first introduced the better stocked areas were as congested as some of our remote unworkable areas are to-day. With the exception of certain accessible areas, thinnings under the older plans were of necessity made at comparatively long intervals to conform with the selection felling cycle. There was of course no classification of thinnings, and marking officers worked in the light of their own experience. A sound common-sense rule was to mark so as to ensure that the thinned crop would have sufficient growing space for the greater part of the thinning cycle and close up during the second half. Much excellent thinning work was done and many of our finest woods evolved through the attention paid to thinnings in earlier days. On the other hand lack of communications made marketing of thinning produce far more difficult than it is to-day. In the early periods the Divisional Forest Officer and his staff had to pay special attention to forest settlement, road construction, demarcation, etc., which left him much less time for personal attention to thinnings than is the case at present. We should also remember that the old divisions were larger in area than the present ones and that the staffs were much smaller. Above all it must be borne in mind, that the state of woods when first taken over, and for a long time after, was such that heavier grades of intensity now feasible were then silviculturally impracticable.

With the advent of working plans based on the shelterwood compartment system, Murree Kahuta (Jerram, 1915) and Kulu (Trevor, 1919) followed by many others written on the same lines, it became obvious that cleanings, early thinnings and regular thinnings were essential if the objects of management were to be attained. There was no standardization, but working plans gave adequate

details of the nature of thinnings required for the various types of woods met with and emphasized the necessity for frequent and regular thinning.

The progress of thinnings was satisfactory in so far as all merchantable and some unmerchantable forests were thinned, and great attention was paid to cleanings and early thinnings. In practice the intensity of thinnings varied considerably according to the experience of marking officers. It was noted that the more capable and experienced thinned more heavily than the inexperienced, and it is true to say that the general practice of thinning was on the light side even for the comparatively short ten-year cycle in vogue. The *following reasons accounted for the tendency to thin too lightly:*

The feeling that a light thinning does at least improve the crop and, if necessary, more trees can be removed, and that trees once felled cannot be put back.

The difficulty for the novice of picturing the result of his markings when felled, and of realising the rate at which the canopy again closes up. European training, mainly among shade bearers, may be largely responsible for a tendency towards light thinnings.

Our forests were full of small blanks and the removal of large trees prescribed outside P. B. I. was bound to create small gaps, which tended to enhance the gap bogey. Inexperienced markers, including large numbers of gazetted officers who joined the Service after the War, were naturally frequently in doubt, and in consequence the rule "when in doubt leave" was over-applied. Thinning is an art which can only be perfected by experience.

With practice and by noting results the tendency to thin much too lightly was overcome. The general increase in intensity that has undoubtedly occurred during the last decade is also largely due to the tuition and example of Mr. Glover and others of the (then) heavy thinning school. Practical demonstration by felling sample thinning areas was found to be the best method of introducing the desired intensity of thinning throughout the division.

When the shelterwood working plans were prepared there were still great irregularities in all blocks, and numbers of large trees,

including misshapen and over-mature trees in P. B.s III and IV, had to be removed. Improvement fellings, generally termed supplementary fellings, were prescribed by area along with thinnings, but in some cases, notably in Kulu and Rawalpindi, the prescriptions were abused. A modified form of shelterwood plan Balsan (Glover, 1926) prescribed the yield of large trees outside P. B. I by volume and gave the numbers of I class trees removable in each compartment, thus regulating improvement fellings. For P. B. I it also prescribed the retention of compact groups of pole-*cum*-tree woods, and, on steep ground, selection type forest, thus reducing the net area under regeneration fellings and increasing the gross area under thinnings. This became the standard plan for our hill forests other than those treated under selection system working plans. Some of the selection working plans permit shelterwood fellings on easy ground and many of them include larger or smaller areas of forest requiring the same type of thinning as in regular forest. By 1930 the majority of merchantable hill forests had been thinned at least twice, and although many of the high level fir and oak forests remained untouched, much admittedly unprofitable thinnings had been undertaken. Punjab Forest Leaflet No. 1 (Trevor, 1931) was issued to ensure a general application of the principles of thinnings and continuity of policy. It showed that thinnings are made not only to increase increment but also as a measure of fire protection, a matter of great importance in pure pine woods and woods containing a mixture of pines. It emphasized the necessity for early and frequent thinnings and insisted on their operation in areas under regeneration (*e.g.*, P. B. I and the youngest P. B. under the shelterwood system) even though the disposal of the cut material, which must not be left on the forest floor, involves expenditure of considerable sums of money.

For plantations it prescribed that the number of plants be reduced to the necessary minimum and gave standardized distances of $6' \times 6'$ for square planting and $10' \times 6'$ for line planting of deoder. For even-aged crops the Indian classification of thinnings described in I.F.R., Vol. XV, Part I, serves as the standard, B grade thinnings were prescribed by the leaflets for first thinnings, C grade for all other

thinnings up to 20" diameter and D grade thinnings in certain cases where preparatory fellings were deemed necessary. For uneven-aged crops excellent rules were given and the maintenance of a canopy of undulating profile was the guiding principle, grades of thinnings being applied for groups of trees, each group being treated on its merits and great caution being taken to ensure that the numbers of trees approaching maturity, on which the future yield depends, were not unnecessarily reduced. By this time a satisfactory state of efficiency in thinnings had been reached, but there was a considerable controversy concerning unprofitable thinnings. Punjab Forest Leaflet No. 1 ruled that the thinnings should commence early and be repeated as often as necessary subject only to the consideration that inflammable material was not to be left lying on the forest floor. Large areas were in consequence left unthinned. Since then, in some cases where woods will eventually prove profitable, thinnings have been made and the trees left lying. As Mr. Champion points out "the economic side of thinning operations in young crops continues largely a matter of opinion—often emphatic opinion." We feel that this is a matter of forest policy best left to the Administration and it will be out of place to discuss it here. Thinnings for rightholders also afford a difficult problem. The habit of distributing in advance and then marking the forest accordingly is silviculturally most unsound. Marking a section for several years' supply to rightholders does not always work well as rightholders by no means invariably take the trees granted. Granting of timber abundantly at the time of thinning and reserving a section to meet interim and urgent demands is sometimes practised, but the difficulty of supplying rights and at the same time ensuring the best silvicultural practice will remain. A reasonably generous policy is indicated, remembering that rights are rights and that villagers help us enormously by removing unprofitable produce.

Apart from such cases thinnings are effectively carrying out the definition given in P. F. L. 1, *i.e.*, to lessen the crowded condition of the crowns of the best trees in a canopy so as to favour their development.

Classification of thinnings.—I.F.R., Vol. XV, Part I (1930) gives four grades of ordinary thinnings as follows:

A=Light thinnings
B=Moderate thinnings
C=Heavy thinnings
D=Very heavy thinnings

and two grades of crown thinnings (LC grade) and heavy crown thinnings (HC grade). The heaviest grades of thinnings D and HC lead naturally to heavy increment fellings. The illustrations have come in for considerable criticism because they show a much heavier result than the text justifies. This, coupled with the fact that C grade is termed heavy ordinary thinning, had led to a very general adoption of C grade. As a natural sequence C grade was frequently used to cover light crown and D grade fellings wherever crops required them, and, considering the same mistake occurred in sample plot work, no blame attaches to ordinary foresters, in fact the reverse is the case.

Practical foresters will note that these classifications apply to even-aged high forest, that D grade must have a wide range and that Hawley's Plate 1 (Unthinned Forest) is used as datum for four ordinary, two crown grades of thinnings, an increment felling, which also serves to illustrate a seeding felling, or coppice with standards. The fact that Hawley has used an extremely congested crop as datum is unfortunate, because even for a C grade thinning 61 per cent. of the total number of trees are removed, including an abnormal number of defective dominants, which would not occur in forests that had been tended. Obviously 30 or 40 years' thinning practice has given a very much better average type of crop than that depicted, and the percentage of trees with normal crown development and good crown form is very much greater, thereby greatly lessening the intensity of a C grade marking. It is easy to be wise after the event, but experienced foresters realised that very heavy thinnings (D grade) must break the canopy for relatively long periods, and therefore the heavy thinnings (C grade) has been naturally favoured by many administrations. In practice C grade was stretched to cover ordinary grade thinnings or crown thinnings as seemed desirable by the

markers or inspecting officers, and it is a fact that generally C became C/D in well marked compartments. Let it be remembered that although Divisional Forest Officers and their staffs had little or no research practice wherewith to apply grades, they did by 1930 have considerable thinning experience.

A C grade thinning rules that all the dominated and suppressed trees had to be removed, while no good dominants (=1a trees) may be removed. In practice it was frequently found necessary to remove some of the good dominants in order to ensure that their neighbours could develop, and it was also found advisable to retain some of the dominated and suppressed trees in many types of woods. In order to overcome this and similar difficulties that arose, Punjab Forest Leaflet No. 1 (a), "Practical hints on thinnings in coniferous woods". (Glover, 1932) was issued. Mr. Glover prescribed grade C as that defined in Howard's Pamphlet 1931 and likened the operation to that formerly defined as a light crown thinning. This amalgamation of ordinary and crown grades of thinnings allows considerable elasticity and is, therefore, well suited to our typical hill forests which are frequently mixed and irregular or regular only in groups. Other factors such as incomplete stocking, two-storied forest, constant variation of site quality, the necessity of favouring the more valuable species and the necessity of marking in a closed canopy, where the removal of a tree may result in a heavier grade than that prescribed, make application of the single type or grade of thinnings impracticable everywhere in our forests. The pamphlet includes a practical guide for each of the main coniferous types and also for mixtures including broad-leaved trees. The necessity for removing suppressed trees in inflammable pine forests, the desirability of retaining broad-leaved trees and the advantages of an admixture of spruce and silver fir as a lower story in kail and deodar woods are points specially emphasized. A particularly happy and far-reaching feature was the inclusion of crown markings.

Selection forests.—Forests of this type occupy extensive areas on steep and precipitous ground where regular working under the shelterwood system is impracticable, and they also include large tracts of remote and unmerchantable woods whose chief value is the

protection of the soil on catchments in areas of very heavy precipitation. Our selection forests include all types of forests met with in the coniferous belt and two of the main objects of management are to keep the ground covered and to produce clean timber of large dimensions. Punjab Forest Leaflet No. 1 includes excellent rules for thinnings in uneven-aged crop managed under the selection system. Many of our selection forests contain groups on comparatively easy ground where ordinary grade thinnings can be practised, but, speaking generally, thinnings of the crown grade type are most suitable and the points emphasized by Mr. Glover apply equally to selection forest. The higher elevation selection forests contain large areas of spruce and silver fir and the lower selection forests include many woods on steep hot slopes where thinnings must be light. Considerable infiltration of side light is afforded on steep slopes to the encouragement of uneven-aged forests. In heavy snowfall regions, such as the Kagan valley, it is advisable to keep the crop irregular to minimise the risk of avalanche and snow-slide.

Inaccessibility, damage by removal of large trees on difficult ground and the large proportion of unmarketable species, all tend to increase the difficulty of applying a systematic thinning regime to the same extent as in many of our forests under the uniform system. The greatest importance attaches to the mixed deodar kail, fir and broad-leaved forests, which produce the finest timber; unless some unprofitable thinning in favour of more valuable species is done, natural selection will favour the less valuable shade bearers. As a rule the thinning cycle must coincide with the felling cycle, which generally takes place at intervals of not less than 15 years, but, in valuable blocks where deodar is introduced artificially, cleanings and early thinnings are practised as required.

Plantations.—These are a special feature of Indian forestry and afford excellent data for thinning research. Besides the plantation of blanks, such as the chir pine plantations of Cantonments in the outer hills and the magnificent deodar plantations of the inner hills, a great deal of plantation work has been done to increase the mixture

of desired species in regular and irregular forests. In the chir forest the clearing technique practised in Hazara and the dibbling and subsequent tending process described in *Indian Forester*, July 1932 (Allah Bakhsh), very definitely facilitate subsequent thinning control, conversely, small patch sowing leads subsequently to waste and difficulty. Careful and well conceived plantation work leads naturally to good thinning practice as instanced by the results in the deodar plantations of Kulu and elsewhere. The automatic stick method of cleaning proved most useful in the past; with the present experience gained in most ranges semi-automatic cleaning in favour of the best stems is preferred. Square planting is regarded with disapproval by many foresters, and planting of 5′×8′ leads to easier thinning control than 6′×6′, but on steep and rocky ground exact spacement naturally gives way to one that suits the plants to the soil.

The standard planting distances prescribed for deodar, 6′×6′ for square planting and 10′×6′ for line planting, have been chosen in order to save the heavy early tending costs. They do in fact reduce plantation costs. From a glance at the Multiple Yield Tables for Deodar (Champion and Mahendru) it would seem that, unless thinnings were to be postponed for a very long time, a heavy grade must operate; there is, however, one important consideration. For plantation work closure to browsing is essential except in remote or inaccessible areas, and considerable natural regeneration can generally be relied upon. In practice widely spaced deodar plantations will include naturally sown kail, spruce, silver fir, oak and other broad-leaved species. Much of the naturally sown kail must be treated as a weed, or it will certainly suppress deodar, but as proved by results in many deodar plantations kail and deodar mixture can be maintained. The net result will be a desirable mixture with a much closer spacing, which lends itself to lighter grades of thinning in favour of deodar. Contour line plantations in high, dense bush, where the bush prevents invasion of naturally sown species and considerably cleans the deodar will remain widely spaced. Here, and in deodar belts kept pure for fire control heavier crown development must ensue, and pruning might be considered.

Spacing.—It is important to remember that, while defective stems are removed, any type of thinnings in Classification of Thinnings, Vol. XV, Part I, is based primarily on the canopy, and thinning must be practised silviculturally according to the development of crowns and their relation to each other. Let us take the case of two acres on the same site quality, one acre being planted with deodar 5′×5′ and the other 8′×8′. If both were left for 25 years and the same grade of thinning (say B) were done in each, the 5′×5′ plantation would still have a considerably closer spacing than the 8′×8′ plantation, neither would spacing be the same if the same grade of thinning in each case were based on the removal of the percentage of the total volume. In other words wider planting and wider spacing in youth lead to wider spacing (within limits) for a given grade. This shows how dangerous it is to use spacement figures as a guide to, or check on, thinnings. In their Multiple Yield Tables for Deodar, Messrs. Champion and Mahendru state that recent thinnings in old and new plots were *marked on the silvicultural prescription of the standard* thinning scale, and that checks based on the relation between number of stems and crops diameter were used only in case of uncertainty. They stress the fact that we may expect a much higher crop diameter from wider spaced woods properly tended from youth up. For ordinary thinning practice, as an occasional *check for cases of doubt, a guide* based on a diameter espacement ratio as given in P. F. L. la (Glover) is the safest.

The thinning cycle.—There can be no precise time table for cleanings and early thinnings; the present practice is to make them when and as required. P. F. L *No. 1 (Trevor) gives as a general guide, for* natural seedlings, an average espacement of 4′×4′ when young trees are 6′ high. This is a very wide early spacing compared with the Multiple Yield Tables for Deodar (Champion and Mahendru), but is merely an early adoption of the correct principle that thinning promotes both height and diameter growth and is designed to avoid costly thinning at a later stage. The sequel, an espacement of about 8′ for an average diameter of over 8″ may even be too low, but the point is that every endeavour is made to start thinnings on sound lines;

foresters who have had to mark very congested crops will appreciate this.

The relation between the intensity of the thinning and the interval is so important that a brief appreciation regarding the general aim is called for. Mr. Homfray, Silviculturist, Bengal, writes: "In Europe, it is generally accepted that a thinning should be made of such an intensity that the canopy will close up within half the period between successive thinnings, and allow the struggle between individual trees in the second half of the period in order to encourage height growth and clean boles." Clean boles are a most important consideration, and for a comparatively short ten-year cycle, in woods where height growth is still vigorous, the closing up of the canopy at half time is probably about right for silver fir, spruce and deodar. For light-demanders, which generally have wider crowns, such as kail, chir and walnut, closing up could be postponed. For longer intervals and for older forests with well cleaned boles, the closing up period can be postponed till, say, 2/3 of the interval has elapsed.

The relation between the grade and the cycle is making itself felt in the Punjab in divisions where thinnings have been operating, until lately, on a 10-year cycle. The earlier thinnings dealing largely with congested woods had to be light and the 10-year was well suited to grades of the B and C and light crown type. The present practice is necessitating an increase of the cycle to 12 or 15 years in many instances.

It stands to reason that one cannot practise very light thinnings at long intervals without intense congestion; neither are very heavy thinnings feasible at short intervals, because the canopy would not have closed up at the end of the interval. The practical ideal lies somewhere between very light and very frequent thinnings, which we cannot afford, and very heavy thinnings at long intervals which will give us low-branched trees of poor market value.

There is a strong, well founded tradition that the earlier thinnings should be light and frequent, and the importance of reducing the intervals between thinnings as much as possible when height increment is culminating, was emphasized at the last Empire Conference, South

Africa. The following is suggested as an example of progressively heavier thinnings and longer intervals for coniferous woods under shelterwood management, past the early thinning stage:

Crown.	*Ordinary.*	*Interval.*	
Light	.. C	10 years	Repeating
Moderate	.. C/D	10—15 years	if
Heavy	.. D	15 years	necessary.

Preparatory.

Modified as necessary to suit the species, progress and crops retained beyond the rotation, etc.

Under shelterwood plans, management can go a very long way to meet the interval requirements of forests, because in practice the usual 10-year cycle rarely rotates exactly, and at revision W. P. O.s put forward Cpts. in need of thinnings and put back others. Some such scheme, in conjunction with our present planting and early tending practice, would seem to combine the aim at growing clean boles with healthy crown development. About the time woods reached P. B. II, they would be fully prepared and left to put on the maximum crown development and increment.

Under selection management the thinning interval must conform to the felling cycle, generally 15 years. Perhaps the best results can be obtained in irregular forest by removing all unsound trees as early as possible and thinning subsequently so as to ensure that after reaching middle age all trees can be left to mature. As Mr. Bourne points out (The Efficiency of Irregular Stocking) the proportion of mature trees to thinnings is thereby increased: a very important consideration in remote forests. Even in group selection it should be possible to eliminate thinnings of II class trees.

Kind of thinning.—P. F. L. 1a recommends Howard's modification of C grade, resembling a light crown thinning, and thereby affording just that elasticity required. Professor Troup shows that the old-fashioned distinction between crown and ordinary grades has broken down in modern European practice and the two merge for the benefit

of the crop.* We are dealing mainly with forests already thinned and the marking officer will be guided by what has gone before. The necessity of cutting suppressed and dominated trees in inflammable pine wood, more or less enforces ordinary grade marking. Elsewhere there is probably a preference for crown grade thinning which, by giving the maximum of help to the best stems may afford a more valuable final yield in a shorter time. Also, well made crown thinnings are better suited to mixtures of species with different light requirements and naturally they are preferred where irregularity is aimed at. A point to remember is that, should a reversion from shelterwood to selection be desired, it would be definitely easier in the case of crown-thinned forests. With our present practice, however, there is no sharp distinction and marking officers will frequently find themselves marking crown and ordinary grade thinnings as needed in the same compartments.

Broad leaf forest.—Within the coniferous belt hardwoods, and especially the oaks, occupy large areas, and broad-leaved species often predominate along nalas and on damp localities in conifer woods. All three of the common oaks have been extensively worked in Simla and *en passant* it may be noted that while improvement fellings prescribing the removal of oak in favour of conifers had been too heavy, thinnings in oak coppice or high wood have generally been too light. Apart from the desirability of broad-leaf for timber, catchment and other purposes, oak, poplar and other species form excellent hosts for conifers, which break through a broad-leaf canopy in a really amazing manner, frequently to form a canopied storey above. Such is probably the origin of many of our finest conifer woods. On the other hand, with the present grazing and lopping incidence, broad-leaf succession stands a much poorer chance. The days of girdling broad-leaved trees are past and it is true to say that the present thinning practice in conifers is to preserve a broad-leaf mixture in order to improve the quality and decrease the fire hazard.

Research.—Considerable scholarship is needed for forest research because the precise assessment of the main factors involved, not only

* Some Recent Silvicultural Development in Europe.

at the commencement but during the course of the experiments, is extremely difficult. As regards the technique and the lines which thinning experiments should follow, the writer cannot give an opinion as he has no research experience—" one must first become an oarsman before handling the rudder" (Sulla). Mr. Laurie promises us a different classification of thinning for young crops in which crown competition and suppression have not reached their full effect, and, at the South Africa Conference, Mr. O'Connor gives an excellent example of an experiment dealing with planting distances and thinning. It is understood that Dr. Gorrie is preparing data correlating the size and vigour of individual crowns in sample plots with their response to growth. We certainly need to know more about the thinning cycle in relation to thinning intensity, and in time we shall probably be able to apply general thinning regimes for the more valuable species and predict the ultimate survivors of the crop at an early stage. The forest research officer is handicapped by the fact that he cannot use models, like the ship designer or aeroplane designer, and thinning experiments are bound to take a long time. A great deal of work has been done in recent years by Messrs. Howard, Champion, Mahendru and others on conifers, and we can leave the matter in the hands of the central and provincial silviculturists with the knowledge that thinning research is receiving adequate attention.

The job and the man.—Our forests are still largely in the transitional stage from virgin forest, and many of them have suffered from fire and over-grazing. Full stocking throughout a whole compartment is rare; in some cases one passes through acres where practically nothing is removable, and in others dense crops are met with interspersed with small blanks where outside trees must be retained. The necessity for maintaining a mixture, for favouring valuable species and the frequent alternative either of thinning more heavily than prescribed or leaving unthinned, call for experience and common sense. The responsibility for seeing that thinnings are properly carried out lies with the D. F. O. His job is to inspect, instruct and, where necessary, to correct. The best method of indication is to

mark, very carefully, sample sections of, say, 10 to 20 acres, felling where possible in cases of doubt. This is far more important than an attempt at marking large areas himself, for that purpose he has a band of skilled Dehra Dun and Ghoragali trained subordinates, of whom some will probably thin on a large scale better than the D. F. O. Some of the best thinning that the writer saw was in the Gallis and Siran valley of Hazara, that was before the days of the leaflets and tribute is undoubtedly due to Mr. Greswell, the author of the working plans. It also tends to show the major part played by the D. F. O., because in those days divisions were small and he was able to give the maximum of personal attention to thinnings.

The thinning leaflets.—These are of the greatest importance in modern practice because they officially override all prescriptions in working plans of the Punjab and N. W. F. P. No two forest officers mark identically, and, as pointed out in the Classification of Thinnings, there can be no sharp distinction between successive grades. Granted that elasticity is particularly desirable, the need for ensuring the general principles of thinnings and continuity is obvious. The writer feels that they have succeeded admirably, but that this is due in large part to the practical manner in which the rules have been applied. The general prescription of C grade thinning affords an excellent example. As Dr. Gorrie (Gradations in Thinning Intensity) points out: "There is perhaps also a tendency amongst senior officers to label as 'C grade' what they personally consider a suitable intensity of marking, as this is the most popular classification, and then expect their subordinates to adopt this particular standard as C grade, no matter whether it really coincides with any official standard or not." Speaking generally, senior officers have not been disappointed, and "C grade" has covered anything from light thinnings in congested pole woods to heavy thinnings where required, stopping short only at preparatory fellings for which the label D is used. The average intensity for ordinary grades probably approximates to C/D, and medium rather than light describes crown grade practice, but our practice distinguishes no artificial barriers and kinds and grades of thinning are made at discretion. The leaflets have been a help in the

Simla division and everywhere they have had a stablising influence. The above remarks apply to regularly thinned merchantable woods. We possess a vast unworked forest area, where the first thinning will necessarily be light, and, in some of our forests prescribed for thinning, C grade or light crown thinnings are quite heavy enough. Therefore, if the leaflets are modified to conform to actual practice, elasticity remains essential.

Conclusion.—The last decade or so has seen a marked tendency towards heavier thinning, evolutionary rather than revolutionary, the natural sequel to experience of the results of past, and generally lighter, thinnings.

THE ROLE OF TREATED TIMBER IN INDIAN STRUCTURAL ECONOMY

By S. Kamesam, M. I. E. (Ind.), Timber Development Officer, Forest Research Institute, Dehra Dun.

Summary.—The article discusses how treated timber can play an important rôle in the structural economy of this country. It is essential, however, that channels of waste in the production, distribution and utilization of timber should be dammed for obtaining the best economy out of treated timber. As far as ultimate economy goes, the present practice of using expensive naturally durable timbers is hardly correct. Wastage in the storage, conversion and seasoning of logs should be reduced to a minimum. Better distribution and marketing facilities, especially for treated timber, should be inaugurated. Standardization of grades, sizes and shapes should be taken in hand. Non-durable timbers without preservative treatment should not be employed. Timber should be treated according to scientific technique, preferably under pressure. The preservatives used should have a sound scientific basis and should have survived severe tests. Timber structures should be designed and joined according to the latest ideas of timber engineering. It is also stated that for structural purposes a diameter superior to 14 inches is hardly necessary so that, as far as use for structural engineering purposes is concerned, a shorter period of rotation may receive consideration from forest officers.

"Political economy and social economy are amusing games ; but vital economy is the philosopher's stone."

—*George Bernard Shaw.*

Never has the world witnessed engineering construction carried out on such a stupendous scale as during the last five or six decades. The world has been knit into one small unit, most countries having been connected by bands of glistening steel with giant locomotives

thundering over them. Skyscrapers with scores of storeys, each accommodating a few thousands of souls enjoying modern comforts, have been put up. Within an astonishingly short period, bridge engineering has become an accurate science. Several remarkable bridges have been installed over rivers that had hitherto defied the wit and efforts of man to span them. In spite of such a colossal upheaval in engineering construction, the question might be asked: "Are there any leaky taps, are there any channels of waste in the present-day choice and employment of structural materials—especially in India?" As far as India is concerned, the answer is in the affirmative. It will be shown that one of the oldest and the most ideal materials of construction available in India has been either sadly ignored for constructing modern structures, or is, often, badly abused where it has been chosen in preference to others.

The main channels of waste in India as regards the choice and employment of structural materials with special reference to timber may be classified as follows:

1. *Waste in selection of structural materials*

(*a*) Ignoring the claims of timber and employing steel and concrete; and

(*b*) employing some very expensive timbers because of their natural durability.

2. *Waste in production and distribution*

(*a*) Growing trees to too large and uneconomical a diameter;

(*b*) waste in storage, conversion and seasoning of logs, etc.;

(*c*) lack of distribution and marketing facilities for treated timber; and

(*d*) lack of standardization of structural grades, sizes and shapes.

3. *Waste in utilization*

(*i*) Insufficient, inefficient or uneconomical protection of timber against fungi, insects and fire.

(*a*) Employing non-durable timbers without preservative treatment;

(*b*) treating timber by faulty or inefficient technique;

(c) employing costly and uneconomical patent "nostrums" of wood preservatives; and

(d) treating timber structures *after* they have been framed.

(*ii*) Uneconomical, inefficient or unscientific design of timber structural members.

(a) Employing rectangular cross-section where round-section can be used with equal facility, less cost and waste; and

(b) employing faulty or uneconomical design of timber structures, especially at the joints.

The science of the selection, production, distribution and treatment of timber and its fabrication into structures is based on the current status of forestry, engineering, business management, physics and chemistry. A river can rise no higher than its source, and waste can appear only when a given process or operation is carried on at a lower level than the present state of human knowledge warrants. Such a level is constantly rising as a result of extensive research all over the world so that the structural timber engineer has to endeavour to raise the level of efficiency of his work to reduce waste to a minimum.

It is no exaggeration to say that engineering construction and maintenance work, costing several crores of rupees, is carried out annually in India. Yet, it might be asked: "Has even a fraction of the claims of properly treated timber in modern engineering construction been appreciated? Has a proper inventory of Indian structural timber resources been made? Has any definite scheme and policy been worked out for the use of treated Indian timbers in the various private as well as governmental public utilities of the country? Is it necessary to give a new orientation to Indian forestry if an extensive utilization of Indian timbers in engineering construction is not merely a matter for speculation but an imminent possibility?" Several similar questions may be asked, but the very basis of the whole matter which is that treated timber *can* compete successfully with steel and reinforced concrete for most structures has not yet been accepted by engineers in this country; most of them have not even seriously considered the question.

The waste involved in the selection of steel and concrete in preference to treated timber for various structures like railway and highway bridges, electrical poles, cross-arms, etc., is of a serious nature.

A tragic waste nearly as serious as using steel and concrete in place of treated timber is instanced in the employment of very expensive naturally durable timbers—although produced in India—in place of antiseptically preserved non-durable timbers for use in outside locations, and also in their employment for purposes where a high resistance to fungi, etc., is hardly necessary. The use of teak for household furniture is an example for illustrating the latter case. If Nature has made teak, deodar, etc., durable, man can make, and has succeeded in making, practically any non-durable timbers even more durable by the injection into them of efficient wood preservative chemicals in requisite quantities. It is possible even to "fire-retard" any timber. In fact, by suitable chemical treatment of timber, it is generally practicable to give special properties to it that are not possessed by any timber in the natural state.

Waste in production and distribution is a channel that deserves to be considered carefully by the timber-man as it is not only a factor that tends to raise the cost of structural timber, but to reduce the available supply of such material or to lower its quality. It has been the aim of the Indian Forest Department to derive the most important portion of their income, as far as timber resources are concerned, from railway sleepers of the specifications now in force. The present practice is to grow, in general, trees for about 80 to 120 years before they are felled and converted. Such large tree stems yield sleepers of the size and quality required at present by the Indian Railways. If, however, round timber (almost irrespective of the species, provided it is sound, straight-grained and free from dead knots) is used extensively for structural purposes after being preserved with antiseptics, it is felt that forestry should receive a new orientation in favour of shorter periods of rotation. It appears that it will pay better to grow trees up to a maximum in general of about 16" in diameter at the base of the tree, in which case obviously much higher

dividends will accrue to the Indian taxpayer as the period of rotation for most species can probably be reduced to about a third of that in vogue at present.

Again, waste in storage and conversion of logs should be reduced to a minimum. At present a considerable proportion of timber felled in the forest is attacked by fungi and insects because it is usually left carelessly and without protection lying on the ground. Either the timber should be carefully stacked over durable supports, or the timber, after being debarked, should be given a prophylactic antiseptic treatment (that does not get washed out by rain in a few months) in the forest soon after felling. The ends should be covered with an efficient anti-splitting composition. With foresight, a considerable proportion of waste during conversion of logs into square timber can be obviated. Logs can be converted so that even the smaller slabs and scantlings can fetch a good price for use in certain specific types of construction or in wood industries as small dimension stock. For many construction purposes, timber can, however, be most economically and efficiently used in the round, half-round or wane form of cross-section. *Such a scheme for economy is, however, linked up* with the question of standardization of structural shapes and sizes of treated timber. After being converted, the planks or scantlings should be carefully air-seasoned (under shelter, if necessary) by piling them over durable supports. Seasoning under optimum conditions will reduce considerably the degrade due to fungi, white-ants and splitting, etc. Any extensive scheme for the utilization of timber for structural purposes, accompanied by minimum waste in production and distribution, is based upon engineers fixing up standard timber sizes and shapes for manufacture into *standard types* of structures. Such a process must be easy of accomplishment in India as the Government own practically the timber resources as well as the important public utilities. The layman and the private engineer can be confidently expected to follow the Government lead. It was the standardization of steel sectional shapes, and their availability at practically any important point in the world that accounts for the great popularity of steel for structural construction. If a proper

effort is made (a start has been already made), it is not impossible, in India, to effect, in a short time, similar standardization in the case of wood. It may be assumed that the safe strength of mild steel and of any air-seasoned timber, almost irrespective of the species, is the same, weight for weight. Hence, it is not strictly necessary to identify each species before purchasing. Its relative oven-dry weight per unit volume can generally be taken as a reliable index to its strength.

Wood will receive a great impetus in its use in engineering construction if standard sizes, grades and shapes are stocked, after suitable treatment, at all important places in India. Considering the several general advantages of timber for assembling into structures, if *durable* timber is made available by a proper and efficient distributing organization, there appears to be little doubt that it will regain in India its former popularity in a short time. It is gratifying to observe that there are about twenty Ascu wood-preserving pressure plants that are working or being installed at present. It will not be an exaggeration to say that in a few months the number will rise to forty.

Lastly, there is the important factor of waste in utilization which should be cut down to a minimum. Engineers have often expressed their disappointment in wood more on account of their own mistakes than due to any intrinsic defect of timber as a structural material. The practice of employing either non-durable timbers or round timber of even durable species like teak in outside locations has naturally given very unfavourable results. That was only to be expected; the sapwood of even teak and other durable species is very non-durable and requires treatment. Even the heartwood of naturally durable timbers is not sufficiently resistant for most engineering purposes if laid in the ground. Even treated timber has in some cases given poor results on account of errors committed by laymen in the method of antiseptic application or impregnation concerned, or in introducing too little or too unevenly of the toxic substance into wood. The technique of preserving wood is not a simple matter; it is highly specialised work and is the job of an expert. Too often has the

engineer preserved timber by a brush treatment with costly proprietary wood preservatives which happen to command a good market more due to high-pressure salesmanship than on account of their intrinsic efficiency. Often such preservatives have been found to be inefficient besides being more expensive than other tested wood preservatives. Even when the best and the most economical wood preservative is injected into wood according to proper technique, the structure may give a poor life if it is not preframed, treated and reassembled so that there is no vulnerable area in the timber structure which remains untreated and exposed to the elements as well as to the enemies of timber.

Waste in utilization may also be considered from the purely engineering standpoint. The practice of utilising timber in the round or in the half-round or wane section as far as possible, not only ensures a very high efficiency of protective treatment with minimum expense and effort, but involves the minimum loss in conversion. It enables smaller trees to be used for structural construction and affords a profitable outlet for the better class of forest thinnings. Too often has the square or rectangular section been insisted on by engineers. It is a costly luxury. The insistence on such a section connotes a tragic waste of structural timber. If timber is properly treated, the factor of safety need not be so high as that which has been assumed before. Experimental data, so far available with structural Indian timbers of the hardwood species, indicate that a lower factor of safety can be used with them than that which has been used with coniferous woods in Europe and America. The factor of safety for properly treated electrical poles need hardly be higher than that used for metal poles in Europe and America. In the case of steel, when used under conditions of impact, an additional impact factor, in other words, a higher factor of safety, has to be employed. With timber, no such impact factor need be considered as the working stresses for timber to resist static loads can be applied without making any further allowance for impact loads.

In the past, there has been a considerable waste of good timber due to inefficient or uneconomical design of timber joints. Recent

progress in the design of efficient timber connectors has revolutionised the design of timber trusses and framed structures, a heavy penalty need no more be paid for the intrinsic weakness of wood in shear. We can now capitalise, on a rational basis, the strong points of timber—*its high strength in tension and compression parallel to grain.* The use of timber connectors definitely encourages preframing and treatment before final assembly. More research is being done in this line and more efficient methods of designing joints will be developed in the near future.

Waste in any practice is inevitable in this world. A part of it is due to ignorance on the part of *Homo sapiens* at the present state of knowledge, for which, of course, there is no finality. There is no excuse, however, for the waste which results from indifference to, or ignorance of, known data, from bad organization, unscientific specifications, faulty design or improper seasoning, storage and treatment of timber for structural purposes. There is hardly any structural material which has been more abused in its use, more wasted between the points of production and installation, and more un-understood or misunderstood than wood. Reduce the waste at the several steps between the points of production and that of structural fabrication, and you have one of the finest structural materials in the world that can be worked with little machinery and that which specially suits the genius, aptitude and even the psychology of the Indian artisan.

It will be clear from the above discussion that there are, at present, several channels of waste in the production, storage, conversion, seasoning, treatment and fabrication of timber that tend to raise the initial and final cost of timber structures, and contribute to its being driven, with contempt, out of the arena of modern structural engineering. All these channels can be dammed effectively. Some suggestions to effect this are as follows:

1. Debarking of and applying a suitable prophylactic antiseptic treatment to logs and poles in the jungles.
2. Proper piling over stone or other supports which will prevent poles from getting fungus attacked by lying in contact with wet ground,

3. Application of anti-splitting composition to ends of logs or stems before conversion or treatment.
4. Use of sound and fairly straight branch-wood.

5. Conversion of timber.

Used preferably in the round, half-round or wane sections.	Sawing into standard shapes and sizes to fit into standard types of structures.

6. Sorting sawn timber into at least two grades, structural and decorative.
7. Proper air-seasoning.
8. Antiseptic treatment under pressure—reseasoning if treated with an aqueous preservative solution.
9. Distribution to several points in the country and storage.
10. Manufacture into standard types of structures like bridge and roof trusses.

Efficient and economical designing especially at the joints.	Use in the round, semi-round and wane forms as far as practicable.

11. Preframing, and retreatment at exposed untreated areas, including water-proofing at joints in important structures.
12. Reassembling and installing the structure at site.

All the crooked trees, stumps, branch-timber, etc., can be cut into small dimension stock which, with proper organization, may be organized into a lucrative rural industry.

If in the near future wood gas producers can be introduced on a large scale into this country, most of the so-called waste timber and slabs that are left in the forest at present can be employed as material for driving motor cars, lorries, engines, etc. It is not improbable that we shall have wood fuelling stations (like petrol stations at present) at thousands of points in the country.

REVIEWS

REPORT ON FOREST ADMINISTRATION IN THE UTILIZATION CIRCLE, BURMA, FOR THE YEAR ENDED 31ST MARCH 1936. (PRICE Rs. 3-0-0).

This annual report of the Utilization Circle in Burma is, as usual, full of interesting matter. The Circle was under the charge of Mr. C. H. Philipp, Conservator of Forests, throughout the year, and he summarises the chief activities of the year as follows:

(*a*) Arranging for the supply and passing of 15,710 specialsized *pyinkado* (*Xylia dolabriformis*) sleepers to the North Western Railway, Karachi.

(*b*) Calculations prior to introducing a "flat rate royalty" for all teak leases.

(*c*) Examining a quantity of poor quality one-star teak logs at the depot with a view to fixing a standard for jungle rejections through the assessment of wastage due to various defects.

(*d*) Observing the cutting of teak logs in Rangoon mills to estimate the conversion loss due to defects with a view to drawing up grading rules.

(*e*) Conducting experiments in conjunction with Princes Risborough on the variation of moisture content of teak strips during transit to England.

(*f*) Conducting experiments on end-coating teak logs at Kyetpyugan depot, Insein Division, with various end-coating mixtures.

(*g*) Organizing experiments on the seasoning and working of teak and *in-kanyin* (*Dipterocarpus* spp).

(*h*) Working up data in connection with a proposal to fix royalties on teak by means of an Index figure.

(*i*) Working up data on beehole squares.

(*j*) Studying variations in the quality of teak timber.

(*k*) Preparation of notes and articles on Burmese timbers, the matchwood industry, the variation in market price of hardwoods throughout the Province.

(*l*) Answering miscellaneous questions on Burmese timbers, lac, cutch, paper pulp, bamboos, tung (*Aleurites* spp.) oil and other minor forest produce.

(*m*) Revised edition of Rodger's Hand-book of Forest Products of Burma.

The financial results of the Circle's working show a surplus of Rs. 13,73,412 as against Rs. 10,89,526 for the previous year and Rs. 3,34,082 for 1933-34. The net revenue increased by 3 lakhs and the expenditure remained practically stationary. The increased revenue was due to a general improvement in markets and prices, and must be considered as very satisfactory.

The seasoning kilns continued to give good service and the year's working shows a considerable increase in the quantity of timber seasoned, of which *yon* (*Anogeissus acuminata*) for tool handles was the chief subject. The actual cost of kiln-seasoning this wood worked out at Rs. 1-3-4 per cubic foot, a very satisfactory result for 2½" timber. Some useful work was also done on air-seasoning *yon*, and several stacks of this species were kept under observation. It was found that partial air-drying for about six months prior to kiln-drying reduced the time of kiln-drying by about 10 days.

Efforts to increase the sale of Burma timbers were started by the production of a very attractive illustrated brochure on Burma teak. This booklet was issued with the help of the principal teak lessees and is a noteworthy example of co-operation between the Forest Department and timber merchants. Such co-operation can but benefit both parties and other Provinces might do worse than follow Burma's example in this respect. There is little doubt that what the Indian Forest Department wants is propaganda and then more propaganda, and one of the easiest ways of achieving this is by co-operation with the interested trades. Improvements in trade results in forest products mean improvements in forest revenue.

The financial benefits accruing from research and attention to possible new markets is well illustrated by the Conservator's remarks in this connection. He states : "When it is realised that this market (tool handles) is capable of consuming at least 4 lakhs of

handles a year and that each lakh represents Rs. 30,000 spent in Burma rather than on imported American hickory, the possibly excessive attention given to this timber (*yon*) during the year seems fully justified."

Speaking of possible markets for box woods he remarks again that "50,000 boxes represent Rs. 36,000 spent in Burma instead of Japan." Such remarks may be truisms, but they illustrate the fact that the Burma Utilization Circle is alive to the possibilities of the situation, and this annual report shows that they are well equipped to take advantage of these possibilities when funds and better times permit.

H. T.

NOTES ON THINNINGS IN PLANTATIONS

BY C. K. HOMFRAY, I.F.S., SILVICULTURIST,

BENGAL (BENGAL FOREST BULLETIN NO. 1, 1936).

The author, during the eleven years he has been Silviculturist in Bengal, has made a special study of thinnings, and this practical and useful little book is the result. The data on which the publication is based is partly taken from sample plots, and partly from information collected in plantations by a system which might advantageously be adopted in other parts of India where plantations are made. Whenever a thinning is to be made, an area, usually about half an acre in extent, is measured out on the ground, and is then marked for thinning carefully by the Divisional Forest Officer, a trained Ranger, or, when possible, by the Silviculturist himself. The age of the plantation, number of stems removed, number left standing, the height of the dominant trees and the mean diameter (estimated if measurement not possible) of the remaining trees after thinning are recorded in the plantation register, a copy being sent to the Silviculturist for his records. In this way a large amount of data was collected and continues to be collected regarding the actual thinning practice in

different divisions and in different crops subsequent inspections enabled the Silviculturist to decide whether the thinning had been too light, too heavy or of the wrong type.

An additional advantage of this method of marking a simple half acre is that it sets a visual standard on the spot for the subordinates who have to mark the thinning to follow. The benefits of this practice were seen in the very high standard of thinning by subordinates, often only forest guards, in the plantations of South Bengal which I visited last November.

The Bulletin under review is issued in a size that slips conveniently into the pocket. The first eleven pages are given up to a general discussion of thinning methods in young crops in which much sound advice is given. Emphasis is laid on the necessity for obtaining even spacing of the crowns from the very start. Sound arguments in favour of the removal of suppressed trees are put forward, and the relation of density of thinnings to thinning cycle is discussed, the chief point being that a thinning must be heavy enough to last until the next thinning is due. In Europe it is generally accepted that as a rough guide the thinning *should be such that the canopy will close up within* half the period between successive thinnings. In Bengal where growth is very rapid and species differ very widely in the tolerance of suppression, experience shows that in species like *Gmelina* and teak the crowns must be kept isolated and never allowed to compete; in species like *Shorea robusta, Terminalia crenulata, Cedrela toona*, etc., it is considered that two rains growing seasons in a five-year cycle or three rains growing seasons in a ten-year cycle is sufficient in which to struggle, and that the crops should not close up for the first three or seven years respectively. In species prone to branching and twistiness like *Lagerstroemia flos-reginae* and *Bucklandia populnea* the crops must be kept in a state of close competition until a sufficient length of clear bole is obtained, and lighter thinnings done. The age for first thinnings in different crops is also discussed and various practical points mentioned.

It is interesting to note that the general trend is towards heavier thinnings in young crops than has been customary in the past. The

book concludes with a series of useful tables of average espacement for given numbers of trees per acre.

The second part of the book gives separate instructions on how to thin young plantations for seventeen different species. The silvicultural characteristics of the species affecting thinning and recommended method of thinning are described. In this it may be mentioned that in some cases the thinnings have been described as "B," "C" or "D" grade. These grades have not been defined, and they certainly do not correspond to the "ordinary thinning" grades given in the official "Glossary of Technical Terms." They are visual standards as empirically judged by the Silviculturist and are becoming familiar to the local staff.

Following the instructions for thinning each species is a table giving the age, height and number of dominant stems to be left after thinning. The age and height are for average quality in Bengal, but if quality varies, height should be taken as the criterion rather than age. The tables were prepared from curves drawn from the data collected as already described. They set a very valuable standard for the guidance of territorial officers who have to carry out thinnings in young crops which they may never have had any dealings with before. The standards set are, admittedly, empirical. Really reliable standards can only be determined by comparative statistical investigations which are laborious to carry out and do not yield results until they have been carried on for many years. The author modestly calls the book a "rough guide," but judging from the amount of data and experience that have gone into its compilation, and from the healthy, vigorous crops and high standard of thinnings seen in Bengal, it is probable that, for many species, the standards set are not likely to be greatly modified for a number of years.

M. V. L.

MONOGRAPH OF THE INDIAN PROTOZOA

THE FAUNA OF BRITISH INDIA (INCLUDING CEYLON AND BURMA). PROTOZOA: CILIOPHORA. BY B. L. BHATIA, *D.Sc., F.Z.S., F.R.M.S.*

(pp. xxii+494, 11 Plates, Map and 214 Illustrations in text). Price 30s. London, August 7th, 1936.

The latest addition to the *Fauna of British India* is a valuable monograph on the Ciliophora, a subphylum of the Protozoa. The unicellular microscopic organisms known as Protozoa are of very diverse economic importance. Many of them as casual agents of various diseases in man and domestic animals are of considerable interest to medical men and veterinary workers while those found in insects afford interest to entomologists. Several species of Protozoa occur in the soil where they influence its fertility; others are found in ponds and puddles.

The volume under review gives a clear and well illustrated description of 310 species belonging to 104 genera, so far known from India, Burma and Ceylon. The most approved and latest classification of the group has been followed, and identification tables of all the families and keys to genera and species dealt with are throughout included, which, together with the lists of parasites and their hosts and *vice versa*, make the volume a convenient work of reference. A comprehensive bibliography of about 50 pages together with the technique will be found of great help to future workers on this interesting group. The author has been working on Protozoa for over 20 years and deserves to be congratulated on this successful outcome of his labours.

B. M. B.

EXTRACTS

*THE NEED FOR SCIENTIFIC STUDY OF INDIA'S CLIMAX VEGETATION

It is estimated that out of her 1,826,924 square miles of land surface, 465,288 square miles or some 25·5% is still under forest growth of one sort or another. The proportion varies greatly in the different provinces, the maximum proportion being found in Coorg (74%) and Burma (60%), and the least in the Punjab (6·7%) and Bombay (11·9%). Disregarding the present political boundaries, there are large tracts such as the Gangetic plain and Berar where practically no forest is found, and others such as Upper Assam and the W. Ghats where there are great blocks of forest but little cut up by human settlements. The forestless tracts are, however, by no means devoid of trees, for scattered mango, neem, figs, tamarinds, and so on are almost everywhere to be seen, silent evidence that the climate and soil are fully capable of supporting tree growth, even if we had not definite historical evidence that most of the land now under cultivation once carried dense forest—as also a good deal of land which though formerly cultivated is no longer fit for crops.

Closer study and comparison with other countries brings out the fact that over practically the whole of India the climax vegetation is forest. There are parts of course, particularly in the Punjab, Sind, and Baluchistan, which are too arid for closed forest, and there are relatively small areas in the high Himalayas which are too high and cold for it, but apart from these extremes, and including thorn scrub as a form of forest, we are left with only a small proportion of grassland, mainly in riverain tracts and on hill tops, about which there can be any doubt. India does not provide the conditions appropriate for the development of climax grassland comparable with the Pampas of S. America, or steppes like those of S. Russia. The actual status of our grasslands will be touched on later.

* Presidential Address delivered by Mr. H. G. Champion, M.A., F.N.I., President of the Section of Botany of the Twenty-fourth Indian Science Congress, held at Hyderabad in 1937.

It is thus clear that forest is certainly India's present dominant vegetation type, and probably its nearly universal climax type also. It might therefore be expected that the tree and its aggregate form, the forest, would provide the material for at least a significant proportion of the botanical studies undertaken, always remembering the still greater importance of agricultural food and economic crops to mankind. It is one of the chief objects of this address to bring to the notice of working botanists how far this is from being the case.

There is another direction in which the value and importance of tree growth to humanity is only beginning to be adequately realised. It may not be a purely botanical matter, but we cannot have plants without soil, and the forest is the great builder and conserver of the soil. That the finest soil, particularly in tropical climates, is to be found where forest has just been cleared has been known further back than our written records, as also the fact that it rapidly loses its fertility on exposure and repeated cropping. That the fertile upper soil is largely destroyed or washed away when the forest cover is destroyed is not generally realised till the pressure on the land becomes so severe that there is no longer enough new land available to which to move when the production of existing fields falls below what is considered worth the labour of cultivation. This is of course the position over all the more densely populated parts of the country. The further stage where sand, gravel, and stones from the subsoil in the upper parts of water catchments are also set in motion by the monsoon downpours typical of the country, leaving the ground denuded down to barren bed rock, and burying good soils further down the natural drainage under almost equally barren and unculturable deposits—is fortunately localised, but has in the last few decades become a matter of first rank economic importance in the Punjab. The loss of soil following on destruction of the natural forest cover and inadequate cultural methods is unbelievably general along the whole length of the great Himalayan Range, and is very apparent on the hill ranges of Southern India. The same processes are in play on the more level ground of our plains, valleys, and plateaux, but are slower, less spectacular, and fortunately more easily countered, but many a field

lies abandoned because the fertile forest soil built up by the original forest is no longer there.

This aspect of trees and forest is of course of special interest to the botanical ecologist, who is concerned with the relations between the vegetation and the habitat, with the origins, changes, and future of existing vegetational types. This subject, too, will be discussed more fully later on.

It is proposed here to make a brief survey of what we have learnt so far about the life history—in the widest sense of the term—of our trees and forests, reviewing in turn the main branches of botanical science. In the course of this survey it will become apparent that from a variety of causes, disappointingly little has been done or is being done, that our present ignorance in India is deplorable, and that instead of leading the world in contributions to scientific knowledge in a field for which we are exceptionally favourably situated, *viz.*, the study of that supreme production of Nature, the tropical evergreen forest, we tend to be content to borrow information and methods of research from northern temperate countries where species, formations and conditions are so very different from our own that the difference is one not merely of degree, but actually of kind. If I succeed in deflecting even a small number of workers from continuing mere duplication of western studies, including the relatively minor fields of teratology, what may be termed routine cytological investigations, compilation of local lists with little attention to relationships, and so on, I shall have achieved my present purpose.

1. Physiology of Trees and Tree Crops

Water Relations

We have information direct and indirect that the water supply in most of the country during the monsoon period is sufficient to meet all requirements and is in fact often in excess. It is a common observation that there is a marked check in growth in many trees during the later part of the monsoon particularly where the rainfall is heavy. It has been suggested that this may be due to lessened

assimilation due to cloudy skies, but the balance of opinion favours the view that it is to be connected rather with the more or less saturated condition of the soil implying poor aeration and stagnation of root activities. A few studies of water absorption from the soil by trees have been published, e.g., interesting studies on some of our mangrove species, but practically nothing has been done on the subject for the normal condition of closed forest growth on typical soils. A good deal of work has been done on the conduction of water up to the foliage of trees because the problem only finds full expression in trees where a height of 200 ft. or more has to be attained. Obviously, however, much work remains to be done to decide between the conflicting theories now in the field, and to determine the conditions under which and the extent to which each may be true. The osmotic forces available in the leaves have been shown to be about 20 atmospheres in fairly typical trees such as ***Azedirachta indica*** and ***Grevillea*** and up to 40 for the xerophytic ***Tamarix*** and even 100 for some mangroves; in the other direction, ***Rhododendron grande*** growing in wet temperate forest showed only 6 atmospheres.

Transpiration also has been studied to some extent in so far as experiments have been made with mango, ***Eugenia jambolana*** and a few other tree species usually under laboratory conditions well outside the forest. These experiments have their value of course, but they only touch the veriest fringe of the problem. The determination of transpiration rates of twigs of trees under set conditions should only be the first step towards the determination of the transpiration data for whole forests for comparison with the data for other types of soil cover and their study in relation to the whole water economy of the tract of country under consideration. Despite the very great importance of this problem to India, nothing whatever has been done so far except a minor investigation carried out in the irrigated plantations of the Punjab to determine the relative effect of a cover of grass alone, of grass with trees, and of trees alone on the moisture of the soil when the same irrigations were given—the immediate object being to see whether the cost of uprooting the grass would be justified by a resultant economy of water. Admittedly, in the West also, knowledge

in this field is backward, but it is attracting attention as one facet of the great problem of counter-erosion and water economy which has pushed itself into the limelight in the last few years. At the moment, India has to depend on very imperfect data from western countries collected under fundamentally different conditions, data which it is positively dangerous to apply without verification. In this connection mention should be made of the figures recently published indicating that transpiration rates increase up to a certain value with increasing temperature and falling humidity and then become more or less stationary. If this is generally true, there may not be so great a difference between the water consumption of forest crops here in the dry or moist tropics, and temperate Europe and America, but the matter requires careful verification.

In these matters, transpiration is of course only one of a number of factors involved, but direct determinations of water losses due to it are most desirable since evaporation from the soil surface, and downward seepage of rainfall are equally difficult or more so to determine. At the moment, we are not in a position to say with any certainty whether under the conditions prevailing in a given spot in India, the afforestation of a bare catchment area on which a city water supply or an important irrigation or hydro-electric scheme depends will increase or decrease the proportion of the rainfall which will be lost by transpiration plus evaporation—there are of course other factors, notably erosion and silting effects, that may render the protective action of the forest cover much more important than a somewhat increased evaporation loss. It may be mentioned that under European conditions, it is estimated that a temperate forest appears to transpire the equivalent of about 3″ to 11″ of rainfall annually.

Assimilation

Equally profound is our ignorance of the assimilation activities of trees and forests.

The forester can supply certain figures which render it possible to compare the relative efficiency of forest and agricultural crops in

utilising the incident light for assimilation, but no one seems to have collected the data and submitted them to any sort of critical study. We harvest the tree crop very largely in the form of ligno-cellulose as contrasted with the sugar, starch, and protein yields harvested in agricultural crops, and at present the value of cellulose lies in its uses as a raw material for industry, not as a foodstuff. However, even apart from any views as to how soon it may be practicable and even customary to depolymerise cellulose into a digestible saccharide, it should be evident that we have here a problem to which pure science could well devote more attention. Once again, we would like to have data bringing out the relative effects of the different temperature, light and moisture conditions characterising temperate and tropical climates. In the same connection, it is of course well known that a tree crop makes far less demand on the soil than any other type of crop. This is natural in view of the fact that food and fodder crops derive a large proportion of their value to us from the mineral substances and the proteins they contain, but it must not be overlooked that the forest crop works with far less wastage of material both mineral and nitrogenous so that it can grow on sites useless for food crops and even on those too poor to carry good grass. And above all, the forest cover far surpasses even the more efficient types of agricultural working in conserving the soil itself and particularly the humus content which in the end is, with solar energy, the source of all productivity.

Assimilative activity depends on the quality and intensity of the incident light. Once more, we have to admit almost complete ignorance of the light conditions prevailing at different levels in our climax vegetational types, namely forests. Recently, one or two forest officers have been taking measurements with some of the electrical photometers which have been put on the market for photographic work, and have obtained some interesting results, but this is a subject which requires to be studied by the trained research worker, not by the professional forester as a small side line among his other multifarious duties.

Respiration

The combined effects of assimilation and respiration form one of the most interesting problems in biology and geochemistry, the carbon circulation of our world, and every scrap of additional knowledge is valuable. The forests are beyond doubt the chief agents in increasing the amount of organic carbon available for the use of the animal world including ourselves, and also in keeping the proportion of the end product of oxidation, CO_2, in the atmosphere below injurious proportions. We require knowledge of respiration processes in the above ground portions of our vegetation to determine what proportion of the carbon assimilation going on there is nett gain, and still more do we require information about the process as it goes on in the soil where there is no assimilation to counteract it, so that local injurious concentrations become possible with far-reaching effect on all the complex processes going on in the soil.

Excretions, etc.

The importance of the rubber growing industry has resulted in considerable work being done on the production and secretion of latex in the American *Hevea*, concerning which I am not competent to speak, but our forest trees are the chief sources of supply of many valuable gums, dammars, resins, and oils.

I am aware of no physiological studies into the production of these substances, and believe that current methods of collection have no scientific basis whatever or are direct applications of foreign methods not systematically tested for Indian species and conditions. The important resin tapping industry of the subtropical Himalayas provides a very good example, offering a big range of interesting and important problems in pure botany with considerable possibilities of economic value also.

The lac industry provides another valuable field to be shared with the entomologist and the biochemist. What are the processes by which the lac insect elaborates so uniform a product from trees which differ so widely, and what are the reactions of the unwilling host in its own food economy? The sandalwood industry is yet

another which still offers a wide field despite the very interesting work of recent years stimulated by the seriousness of the spike disease.

2. Soil Problems

This is not perhaps the place to go into soil problems at any length, and yet it has been impossible to avoid all reference to them in the earlier parts of this discourse. The groups of problems with which the botanist is most immediately concerned are those which deal with the humus and the nitrogen cycles. Once again the forest takes foremost place as the great manufacturer of humus and apparently the most economic user. Our need is for Indian data for rates of humus formation with different types of vegetation, for comparative qualitative studies of humus and humus conservation, and for all we can find out about the nitrogen cycle under our own climatic and soil conditions.

3. Genetics

The long life cycle of trees places a serious obstacle in the way of the would-be student in the field of tree genetics, and yet that very fact should be an incentive both because difficulties ought to stimulate the scientific worker, and because the longer it is going to take to obtain the answer to a problem, the more important it becomes to make an early start. One is prepared to admit that the general principles evolved from western studies are more readily acceptable for genetics than for physiological problems, even though the higher temperatures and different seasonal variations may well result in a very different tempo for evolutionary processes. This admission however only leaves us with a realisation of the vast amount to be done in this country even if we only have to work on our flora on the lines thus made apparent. I was faced with an interesting problem of this type when I first came out to this country over 20 years ago, and was fortunate in being able to initiate a study on the inheritance of spiral grain in pine which has in the meantime provided us with the only clear case we have among our thousands of species of forest trees of the inheritance of a character of this kind, actually a serious defect

in timber. Even so, the research falls short of much that it might have accomplished because the controlled pollination which would certainly have been effected by the whole time physiological worker was not practical to the forester, at least at that time. We also have co-operative study under way in seven provinces and States, of the characters and heredity of the racial strains of the chief timber tree of the East, *viz.*, teak. At the Forest Research Institute, and at the Lac Research Institute, the physiological races of various lac hosts, and many other connected variations, are being examined, almost any one of which is really a whole time study for the trained research botanist.

Selective Breeding

The large amount of work done on food crops and the great economic value of the results in raising actual and potential agricultural outturns are now universally recognised. It is also known that valuable results have been obtained with other economic crops such as rubber by systematic work on selective breeding and improved methods of rapid propagation of a good stock or strain when isolated.

The importance of forestry in India may appear small in comparison with agriculture, but that does reduce the relative value of similar work on trees to both pure and applied science, and the trees at the moment offer an attractive virgin field. Many trees produce individuals with timber much more ornamental than usual for their species, and apparently from no external cause: what are the reasons for it ? is it a heritable character? and can a strain be isolated which will reproduce it in all or a high proportion of its offspring ? Some pine trees yield 50 to even 100 per cent. more resin than the average for trees of the same size and age growing under the same conditions; on the analogy of *Hevea*, it should be possible to isolate high yielding strains, but the worker is still lacking to try.

Hybridisation

Hybridisation of forest trees is a new study even in the west, but it apparently has possibilities, and there are reported cases of pronounced hybrid vigour in the first generation. India has co-operated in American work in this field but so far done none herself.

4. Ecology

Root Competition

We have become aware of recent years of the important part played in plant survival by the unseen competition going on below the surface of the ground. The problem is of course far more difficult to follow in trees than in herbaceous plants and has hardly been touched in this country under natural conditions for which the valuable studies on orchard trees can only provide suggestions. In some ways the reactions between the different types of vegetation are almost more interesting than those between individuals of the same species in the same or different stages of development; these reactions of course underlie the whole problem of plant succession. We have the results of a few small experiments on natural regeneration of deodar, etc., and workers in Java have published some valuable observations on the effect of adjoining vegetation on the development of teak plantations, demonstrating that it is more competition for moisture than for mineral food that is in question. The matter is an important one for us in all the drier parts of the country and offers yet another interesting and useful field for research.

Crown Competition

This subject is one with which the forester is probably better able to deal than most professional botanists, and so it can be left to him.

Succession

As a result of the understandable desire for results within a reasonable period of time, successional studies have been concentrated in undue degree on the shortlived types of vegetation. Probable successions of forest types have been built up by foresters by deduction from general observation of the present distribution of more or less distinguishable types: the simplest are undoubtedly correct but much more specialised study by experienced workers is needed

for the rest. Forest Departments throughout India have during the last few years been selecting suitable areas of forest of all the chief recognised types with a view to excluding them from all working, and rendering them available for scientific study, especially in the field under discussion. It is however unlikely that a great deal can be done in them without the collaboration of botanical workers in a position to devote a good deal of time to the problems they take up, and facilities would gladly be given.

The ecological status of very many of our forest types is a controversial matter. One of the papers presented to this Congress deals with the status of the sholas and grasslands of the S. Indian Hills which is a problem full of interest from many points of view and this is only one of a hundred similar opportunities. It has become apparent of late that many of our important revenue producing sal (*Shorea robusta*) forests are only a preclimax rendered stable by the periodic burning to which they have been subjected in the past; the probable climax is on present values a definitely less valuable type.

This leads us to the nature of the climax vegetation itself. I have claimed at the outset that for by far the greater part of the country, the climax is tree forest, but it is not necessarily the forest we find on it at present as just suggested for some of our sal forests. Some parts of the country have been so universally and fundamentally influenced by human habitation that it is now practically impossible to indicate any area which can with confidence be claimed to carry the natural climax vegetation, as is the case for the whole of the Gangetic plain of the U.P., Bihar and Bengal. There is considerable academic interest in the question as to whether the accepted climax forms really can maintain themselves, or whether there is a natural rotation of crops, perhaps of the same vegetative form but of different species. This point arises in many types in which, as for the fir forests of the W. Himalaya, the apparent climax tree forest appears to generate soil conditions in which its own regeneration cannot take place.

Distribution Problems

The tree, being large and long-lived, provides excellent material for studies of actual distribution and its underlying causes which do not seem to me to have been fully utilised. Once again, since trees form the dominant vegetation, it is their distribution which must chiefly have determined the whole biological history of the country in the past.

5. EXPERIMENTAL TECHNIQUE

It is obvious that the study of trees will frequently call for a *different technique from that suitable for smaller plants which can be* brought into the laboratory, or to which ordinary laborartory methods can usually be applied in the field, and this has no doubt had a lot to do with the relative neglect from which trees have suffered. The trouble lies in the great size of the unit and the fact that it is very difficult either to reproduce the conditions under which the average tree is growing, or to control them. It is difficult enough to determine *what the conditions* are in the crown of a tree perhaps 100 ft. above the ground, or at its roots which, though normally mostly in the upper 10 ft. or so of the soil, may penetrate to a depth of even 100 ft. However, as in all other branches of science, these difficulties exist to be overcome, as some of the work done by members of the Oxford University Exploration Society in tropical evergreen forest has shown.

This increased dimensional scale applies to areas also, so that the small quadrat of ecological and succession studies becomes of very little use. Forest workers have accordingly gone over very largely to long linear transects, and to get true samples, experience shews that they must be very long ones. Again it is usually necessary to work over at least five acres to reproduce the desired conditions as to light intensity and general exposure on the floor of the forest in making studies of regeneration.

The problems of sampling call for special intensive studies under forest conditions. The theory of small samples figures prominently

since it is rare that experiments or observations can be replicated enough to provide data capable of analysis on the lines developed for agricultural practice, where a square yard sample will meet most requirements and will itself represent the growth of a large number of individual plants.

SUMMARY

Very little is yet known about the physiology of the individual tree, and still less of the physiology of tree crops. What little information has been obtained nearly all refers to temperate climates, leaving the tropical forests almost unexplored. Only small beginnings have been made in the study of the tropical forest in relation to the soil, to genetic problems and to ecological problems of competition and succession. The study of trees and crops calls for a special technique both in the collection of data and their analysis. India is in a unique and very favourable position to lead the world in this field, the problems awaiting solution being full of interest to the scientific worker and full of importance on their economic side.

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for December 1936:

IMPORTS

ARTICLES	MONTH OF DECEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
Siam ..	150	36	55	30,329	3,744	6 092
French Indo-China ..	101	..	..	11,929	..	..
Other countries ..	..	..	501	..	..	51,205
Total ..	251	36	556	42,258	3,744	57,297
Other than teak —						
Softwoods ..	988	1,142	654	63,633	56,529	37,269
Matchwoods ..	..	..	916	..	..	57,855
Unspecified (Value) ..	..	..	..	1,71,402	1,35,458	21,169
Firewood ..	32	10	28	480	100	420
Sandalwood ..	2	2	14	1,244	1,728	6,744
Total value of wood and timber ..	..	..	..	2,79,017	1,97,559	1,80,754
Manufactures of wood and timber—						
Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	238	..	..	61,085
Tea chests (Value) ..	..	..	..	*3,47,241*	*3,10,811*	*5,43,770*
Other manufactures of wood (Value) ..	..	..	..	1,58,773	2,04,352	1,55,829
Total value of manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	5,06,014	5,15,163	7,60,684
Other products of wood and timber—						
Wood pulp (Cwt.) ..	14,832	21,597	21,104	1,16,559	1,48,960	1,42,395

IMPORTS

ARTICLES	NINE MONTHS, 1st APRIL TO 31st DECEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
Siam ..	3,553	277	854	3,89,836	26,616	1,07,619
French Indo-China ..	3,099	425	2,408	2,59,606	49,479	2,43,149
Other countries ..	..	148	1,329	89	14,965	1,46,837
Total ..	6,652	850	4,591	6,49,531	91,060	4,97,605
Other than teak—						
Softwoods ..	8,166	8,869	12,172	5,33,295	5,30,341	7,29,930
Matchwoods ..	..	..	8,266	..	..	4,63,893
Unspecified (Value) ..	..	..	..	10,96,305	13,23,654	2,57,785
Firewood ..	537	388	294	12,040	5,727	4,398
Sandalwood ..	253	182	221	79,992	67,653	69,417
Total value of wood and timber ..	..	..	..	23,71,163	20,18,435	20,23,028
Manufactures of wood and timber—						
Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	2,184	..	..	5,15,554
Tea chests (Value) ..	..	..	..	30,48,532	36,62,090	34,68,226
Other manufactures of wood (Value) ..	..	..	..	15,23,667	18,65,767	11,19,449
Total value of manufactures of wood and timber other than furniture and cabinet-ware	..	..	..	45,72,199	55,27,857	51,03,229
Other products of wood and timber—						
Wood pulp (Cwt.) ..	305,499	239,765	165,054	20,61,504	15,89,076	10,78,946

EXPORTS

ARTICLES	MONTH OF DECEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	1,892	3,434	4,182	3,90,801	6,52,698	8,64,921
,, Germany ..	69	177	691	14,055	37,088	1,83,756
,, Belgium ..	11	..	24	2,964	..	4,481
,, Iraq ..	99	87	36	23,208	11,174	6,262
,, Ceylon ..	25	102	205	2,750	12,175	21,867
,, Union of South Africa ..	126	175	1,009	21,516	28,698	2,17,370
,, Portuguese East Africa ..	57	197	287	9,847	29,958	49,965
,, United States of America ..	127	..	..	32,059	..	..
,, Other countries ..	211	324	965	42,495	71,908	2,08,479
Total ..	2,617	4,496	7,399	5,39,695	8,43,699	15,57,101
Teak keys (tons) ..	273	368	351	41,025	55,125	51,267
Hardwoods other than teak ..	1	67	30	76	6,700	3,000
Unspecified (Value) ..	..	..	..	40,362	15,296	1,69,496
Firewood (tons) ..	..	1	..	..	11	..
Total ..	..	..	..	81,463	77,132	2,23,763
Sandalwood—						
To United Kingdom ..	..	15	..	..	15,656	..
,, China (excluding Hong-Kong) ..	..	..	12	..	..	16,017
,, Japan ..	10	12	12	10,500	13,540	15,727
,, Anglo-Egyptian Sudan ..	8	3	3	9,000	3,925	2,800
,, United States of America ..	..	65	2	..	65,000	1,600
,, Other countries ..	..	3	..	998	3,085	575
Total ..	18	98	29	20,498	1,01,206	36,719
Total value of wood and timber ..	..	..	..	6,41,656	10,22,037	18,17,583
Manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	6,464	5,085	18,691
Other products of wood and timber ..	No data.			No data.		

EXPORTS

ARTICLES	NINE MONTHS, 1st APRIL TO 31st DECEMBER					
	Quantity (Cubic Tons)			Value (Rupees)		
	1934	1935	1936	1934	1935	1936
Wood and Timber						
Teakwood—						
To United Kingdom ..	19,500	25,775	32,966	42,88,240	49,99,425	68,09,726
,, Germany ..	1,378	3,811	3,603	3,35,179	8,77,461	8,83,419
,, Belgium ..	259	702	247	51,599	1,35,099	39,696
,, Iraq ..	753	848	441	1,55,296	1,50,262	85,026
,, Ceylon ..	533	817	1,084	75,740	1,11,661	1,52,755
,, Union of South Africa	2,275	2,469	5,025	5,06,440	4,09,001	10,29,016
,, Portuguese East Africa ..	230	1,067	1,587	38,392	1,80,401	2,70,641
,, United States of America ..	528	313	373	1,50,696	76,628	1,08,361
,, Other countries ..	2,904	3,457	4,839	5,40,666	6,61,489	10,52,965
Total ..	28,360	39,259	50,165	61,42,248	76,01,427	1,04,31,605
Teak keys (tons) ..	2,598	3,441	2,792	3,71,519	5,07,752	3,94,397
Hardwoods other than teak ..	571	643	1,171	57,067	70,390	1,21,738
Unspecified (Value) ..	..	..	..	..	..	..
Firewood (tons) ..	132	30	..	2,403	447	..
Total ..	..	..	..	4,30,989	5,78,589	5,16,135
Sandalwood—						
To United Kingdom ..	31	27	7	38,986	30,216	6,800
,, China (excluding Hong-Kong) ..	36	25	71	58,685	35,490	87,577
,, Japan ..	50	83	68	54,169	90,939	1,26,358
,, Anglo-Egyptian Sudan ..	44	58	57	48,300	73,015	65,335
,, United States of America ..	288	390	340	3,38,800	3,93,290	3,76,548
,, Other countries ..	14	35	39	28,033	41,496	53,202
Total ..	463	618	582	5,66,973	6,64,446	7,15,820
Total value of wood and timber ..	..	..	..	71,40,210	88,44,462	1,10,49,693
Manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	91,403	71,486	1,01,953
Other products of wood and timber ..	No data.			No data.		

INDIAN FORESTER

JUNE, 1937

IMPERIAL FOREST COLLEGE, DEHRA DUN, CONVOCATION DAY

The 1935-37 Forest Rangers' Course closed at the end of March. To mark the occasion, Saturday, 3rd April, was observed as a holiday. In the morning there was the usual convocation and the annual sports of the Institute and College were held in the afternoon.

The morning function was held in the magnificent Convocation Hall of the Forest Research Institute before a large gathering which included officers and their wives and the students of the new 1937-39 Course.

In the unavoidable absence of the Honourable Kunwar Sir Jagdish Prasad, K.C.S.I., C.I.E., O.B.E., the prizes and certificates were distributed by Sir Gerald Trevor, C.I.E., Inspector-General of Forests.

Award of certificates in order of merit

Honours.—Nathi Singh (United Provinces); Lyngstong Rynjah (Assam); Ramanand Gairola (United Provinces); Mehtab Ali (Chamba State); K. M. Idris Hossain (Bengal); Nur-ul-Hassan (Punjab); Mazir-ud-Din Ahmed (Bengal); Baleshwar Prasad Singh (United Provinces).

Higher standard.—Surendra Pratap Sahi (United Provinces); Ram Nath Sharma (Kashmir State); Ahmed Nawaz Khan (North-West Frontier Province); Abdul Aziz Chowdhury (Bengal); Sham Lal Nagpal (Kashmir State); Lalji Punja Ratnania (Kutch State); Mohd. Siraj-ud-Din (United Provinces); Bija Mal Singh Negi (Sirmoor State); Umed Singh Bora (United Provinces); Mohd. Aslam Khan (Punjab); Amiya Nath Bannerji (Bengal); Shah Abdul Aziz (North-West Frontier Province); Janardon Das (Bengal); Muzaffar Ali (United Provinces); Mohd. Azim (Kashmir); Ramsinghji Kanji

Rathod (Kutch State); Ghulam Rasool (Kashmir State); Kanji Vaghji Gohil (Kutch State); Nand Lal Dev Varman (Tripura State).

List of prize-winners

Honours Gold Medal ..	Nathi Singh (United Provinces).
Silver Medal for Botany ..	Mazir-ud-Din Ahmed (Bengal)
Silver Medal for Forest Engineering.	Mehtab Ali (Chamba State).
Silver Medal for Forestry ..	Nathi Singh (United Provinces).
Fernandez Gold Medal for Utilisation.	Lyngstong Rynjah (Assam).
McDonnell Silver Medal (to the *best practical forester).*	Ramanand Gairola (United *Provinces).*
Indian Forester Prize (to the best student who has received no other prize).	K. M. Idris Hossain (Bengal).
Director's Prize (to the second best student who has received no other prize).	Baleshwar Prasad Singh (United Provinces).

Marathon Race

Inspector-General of Forests' Cup	Nur-ul-Hassan (Punjab).
2nd Prize ..	Ghulam Rasool (Kashmir State).
3rd Prize ..	Mohd. Siraj-ud-Din (United Provinces).

DIRECTOR'S ADDRESS.

Mr. W. T. Hall, B.SC., I.F.S., *Director of the Forest College, opened* his address by offering congratulations to the Inspector-General and Lady Trevor on Sir Gerald's recent honour, and thanking him for the great personal interest he had taken in all the activities of the College. Continuing, he said :

"It is now my duty to give you a brief account of the work of the College and of the course which has now closed.

The Forest Rangers' Course lasts for two years. I have received hundreds of enquiries about it and I would like to mention that we

do not accept private students unless they are previously assured of an appointment. Provinces and States appoint their own probationers and all that we insist on is that students should have a standard of education sufficient to benefit from the instruction. For this reason we ourselves set and mark the papers for the qualifying entrance examination.

In this class we have had 27 students of whom 10 came to us from Indian States—Kashmir, Chamba, Sirmoor, Kutch and Tripura. The remainder were sent from the Provinces of the Punjab, North-West Frontier, Bengal, Assam and the United Provinces. For the 1937-39 course we shall have 31 students. They are present here to-day and I take this opportunity of welcoming them to the College.

There must be few officers in the service who have not been asked at one time or another 'what *does* a forest officer do ?' Some people seem to think we do little more than shoot and fish and draw our pay. Actually, a forest officer's work is never finished and I make bold to say that in no other service has an officer to be such a jack-of-all-trades. I would like to emphasise now that the Forest Ranger is the backbone of the forest services in India. Without his loyal co-operation most of your research work at the Institute will be in vain. These students who are leaving us to-morrow will eventually be in control of the largest administrative units in forest divisions—*i. e.*, of a forest range, with an area which may contain up to 150 square miles of forest. They will have to take on their shoulders great responsibilities often under the most trying physical conditions. Every divisional forest officer therefore places the greatest importance on their training.

In the time at my disposal it is quite impossible to give you more than a very general idea of a Forest Ranger's training. We have to keep in mind the strenuous life they have to live in the forests, and whilst at the College we try to keep them in the best possible physical condition. We employ the services of an Army Instructor to give them an hour's physical training before breakfast every morning. We have provided them with three good tennis-courts and last year we laid out a new playing field inside the College grounds. In our

sports and games I have done my best to foster a spirit of co-operation with the staff of the Forest Research Institute.

On the more serious side of our work at the College, I would first like to mention forest engineering, a subject which to the Indian Forest Ranger is second only in importance to forestry itself. The Divisional Forest Officer is responsible for the plans, estimates, construction and maintenance of all forest buildings in his division. Too often he has to rely on a very poor class of contractor. It is thus all the more essential for the Forest Ranger to have a sound working knowledge of building materials and construction and lectures on forest engineering are given throughout the course. A forest officer is also responsible for the construction and maintenance of hundreds of miles of roads and instruction is given in road-making and bridge construction. Theoretical and practical training in surveying is necessary and each student has finally to make a survey plate of a plot of ground.

One afternoon per week when we are in Dehra is devoted to engineering drawing and each student has to prepare the plan and estimate of a road, a bridge, a masonry culvert and as many kinds of forest buildings as we have time for. I need hardly remind you that a good deal of elementary training on more simple subjects is necessary before that stage is reached. Apart from general principles, it is little use teaching a Forest Ranger in the hills the types of buildings used in the plains or a student from Bengal and Assam the types used in the United Provinces. For this reason we have now obtained plans of standard or common types of buildings used in various Provinces and States. During our tours we study works which are under construction and we were indebted to the Commandant of the Bengal Sappers and Miners for a most valuable course of practical training at Roorkee. During this course, the students constructed a trestle bridge, a suspension bridge and a cantilever bridge. They also constructed a 20-foot derrick and amongst other things had practical instruction in the handling and use of explosives.

When the students come to us they are supposed to have an adequate knowledge of elementary mathematics but we find that we

have to revise their knowledge to appreciate the lectures on forest mensuration. This deals chiefly with the methods of calculating the contents of felled and standing trees as well as of whole woods.

We also give instruction on elementary physical science, partly as an introduction to a more intensive study of soils in relation to forest growth.

I need scarcely stress the importance of botany in the training of a Forest Ranger and lectures on botany are given throughout the course. Whilst in Dehra, one afternoon per week is devoted to practical work for which we have a well-equipped laboratory. We have good herbarium collection and last year Kanjilal's flora of the Doon was transferred to us from the Forest Research Institute. During tours the students learn the local flora as a matter of routine and they had to collect and mount at least 50 specimens for themselves, chiefly the more common shrubs.

Forest utilisation is naturally one of the major subjects and lectures on this subject are given throughout the course. Demonstrations were given by the officers of the Economic Branch of the Institute.

A Forest Ranger has constant dealings with contractors, sawyers, fellers, labour of all kinds and with the local population. One of the tests of a good Ranger is the way he handles them. It is absolutely essential for the Ranger to maintain good relations with the local villagers whilst protecting his forest against depredations of all sorts. For this purpose he is armed with certain powers under the Forest Act and we have to teach him this as well as the general principles of Forest Law.

In addition to protection against injury by human agency, injury from wild animals, fire and so on, he has also to learn how to protect his forest against insects and fungi and instruction on these two subjects was given by Mr. N. C. Chatterjee of the Entomological Branch and by Dr. Bagchee, the Forest Mycologist.

Most of the expenditure in the Forest Department is incurred through the agency of the Forest Rangers and we have to teach the students the method of maintaining forest accounts and records,

You will have observed that up till now I have not even referred to the subjects of silviculture and forest management which are of course the most important subjects in a forest officer's training. I shall not worry you by even attempting to tell you what they deal with beyond saying that you cannot make a silviculturist in the class-room. Class-room lectures are of course essential and inevitable, but we rely to a very large extent on practical training in the forests. For this purpose, Dehra Dun is an exceedingly convenient centre. I would like to say now that my experience as Director of the Forest College during the last two years has convinced me more than ever that the best place to train our future gazetted Indian forest officers is at Dehra Dun and not in Europe. I do not mean to imply that we still haven't a lot to learn from other countries, but, during the last 20 years particularly, we have developed a forestry technique of our own which is in no way inferior to that of any country in the world. Whilst we mainly endeavour to teach the students general principles of forestry, we are now able to demonstrate these principles in our own forests under Indian conditions and under modern scientific systems of management which fully meet the requirements of training our young officers.

For this purpose the students of the present course have made extensive tours in the forests of the United Provinces, *viz.*, in Dehra Dun, Chakrata, Almora, Gorakhpur, North Kheri, Pilibhit and Haldwani; also in the forests of Kulu and in the irrigated plantations of the Punjab. We are very grateful to the divisional forest officers and staff of these divisions for the excellent arrangements made for our comfort and instruction.

The technical management of our forests is prescribed in what is known as a working plan. This briefly is a printed book which describes the forests and gives the history of its past management. It also lays down in what manner the forests will be managed in the future during a period of 10 to 20 years. Working plans are always written by a gazetted officer but he is assisted in certain branches of the work by a Forest Ranger. All our training in forestry at the College has in view that the Forest Ranger should be able to study

any working plan with understanding and intelligence and carry out its prescriptions with efficiency. At the request of the United Provinces I revised the working plan of the Landour Cantonment forests last summer so the students of this course have had practical experience of this rather specialised form of forest work.

I now come to the results of the examinations. The Provinces and States require that their probationers should reach a certain standard of efficiency before they are considered fit to pass out as Forest Rangers. Unfortunately, no educational institution, as far as I am aware, has been able to solve this problem satisfactorily without having recourse to examinations. The students may not agree with me but they pain the instructors more than they pain them. With this course we have set up the precedent of appointing external examiners for the final examinations and in so doing we have emphasised the status of the Forest Rangers' Course at Dehra Dun and the importance we attach to the training of our Forest Rangers.

Mr. Hamilton, Deputy Conservator of Forests in the Punjab, was responsible for the examination in silviculture and forest management, both oral and written. Mr. Duncan, Deputy Conservator of Forests in the United Provinces, for forest engineering. For the other examinations we had the services of the experts of the Forest Research Institute including the Inspector-General himself. We are very much indebted to these gentlemen for their assistance.

I am glad to be able to announce that the President of the College has passed all students on the Higher Standard and has granted Honours certificates to eight students.

I shall now request the Inspector-General of Forests to distribute the certificates and prizes and I shall call up the students in their order of merit."

Inspector-General's Address

After distributing the prizes and certificates to students, the Inspector-General of Forests delivered his address.

"LADIES AND GENTLEMEN, STUDENTS OF THE FOREST COLLEGE,

It is just two years since I addressed you on the reopening of the Imperial Forest College. In that address I brought to your notice some of the facts connected with the history of this College which has done so much for the development of Indian forestry. I pointed out to you students, who are now about to leave the College, the distinguished careers attained by many of your predecessors. You have now completed your education at the College and are now about to go out into the world and earn your living in the profession you have chosen. Do not think, however, that your education is over. The education of a forest officer is never over. You will be faced with new problems, new ideas and improvement in methods. What you have to do if you wish to be a success in life is to study day by day the forests in which you live and work, to seek diligently to acquire knowledge. I once said in a public speech that according to Arabian legend Solomon had been endowed with the knowledge of the language of birds and that the master of silviculture should similarly be endowed with the knowledge of the language of trees. I commend this great thought to you to-day at the opening of your careers. For 34 years I have served the forests of India and this is the last time I shall address the students of the Forest College. I have seen Indian forestry emerge from the comparative obscurity of selection-cum-improvement to take one of the foremost positions in the world. Our predecessors laid the foundations of Indian forestry, they created and organised the forest estate, demarcated the forest, built roads and rest-houses, started plantations. The work they did under the most appalling discomforts is to-day the memorial of their greatness. Many of them laid down their lives in the execution of their duty and you will find their graves in the forest. During the time I have served in India we have built on these foundations so surely laid by our predecessors. We have elaborated silvicultural treatment and working plans, we have solved many technical problems. The forestry of to-day is very different from that of 1903 when I joined the service. It is for you to maintain

and improve the great work which has been done. Great responsibilities will in due course devolve upon you; you will be entrusted with the care and management of a considerable estate. Look upon your range as you would upon your own garden, to protect it, to care for it, to beautify it, remembering that the wilderness is the Garden of God and that you and I are the *malis* of this garden. Seek always to do your duty to the forests placed in your charge, to your subordinates and the people with whom you come into contact, to deal honestly and fairly with all men, to consider not your personal comforts but your duty to the great service of which you are about to become members.

If you so conduct your lives you will at the end be able to look back with satisfaction on your career and even if the rewards of this world pass you by, you will have the greatest of all rewards—the knowledge that you have served your country well. We have done all we could do here to fortify your minds and your bodies. You have improved mentally and physically and I hope you will be able to look back with pleasure on the two years you have spent at the College; that you will turn out a credit to this old and great institution and to your Director and his staff who I know have done their utmost for you. Now the time has come for me to bid you farewell. You will disperse all over India and with you you will take the good name of Dehra Dun. May you be happy in your lives and successful in your careers.

I must now say a few words to the new class which I meet to-day for the first time. You are at the beginning of your careers. You are about to follow a long line of men trained in this institution since 1878, some of whom have risen to the top of their profession. The success of Indian forestry has largely resulted from the devoted labours of Forest Rangers who occupy an honoured and honourable place. They are the men who have to carry out the technical operations of natural regeneration, of sowing and planting, of road and bridge construction, of fire protection. If any one has to catch wild elephants it is the Ranger who is ordered to do so. He is the man who has to

make the *bundobast* for everything. It is our job here to teach you all these things, to turn you out as competent and self-reliant members of the forest service. It is your job to make the best of your advantages while at the College, to learn all you can, to develop both your minds and your bodies for the struggle of life, to learn to obey so that later on you may be able to command. Politics have no place in forestry as I said two years ago ; all we are concerned with is the care of the forests of India which in due course will be committed to your charge. I am glad that you have had an opportunity of meeting your predecessors who no doubt have already made you acquainted with the worst. I should, however, like to assure you that while we shall do our best for your instruction we shall also endeavour to make your stay at the College one of the happiest periods of your life."

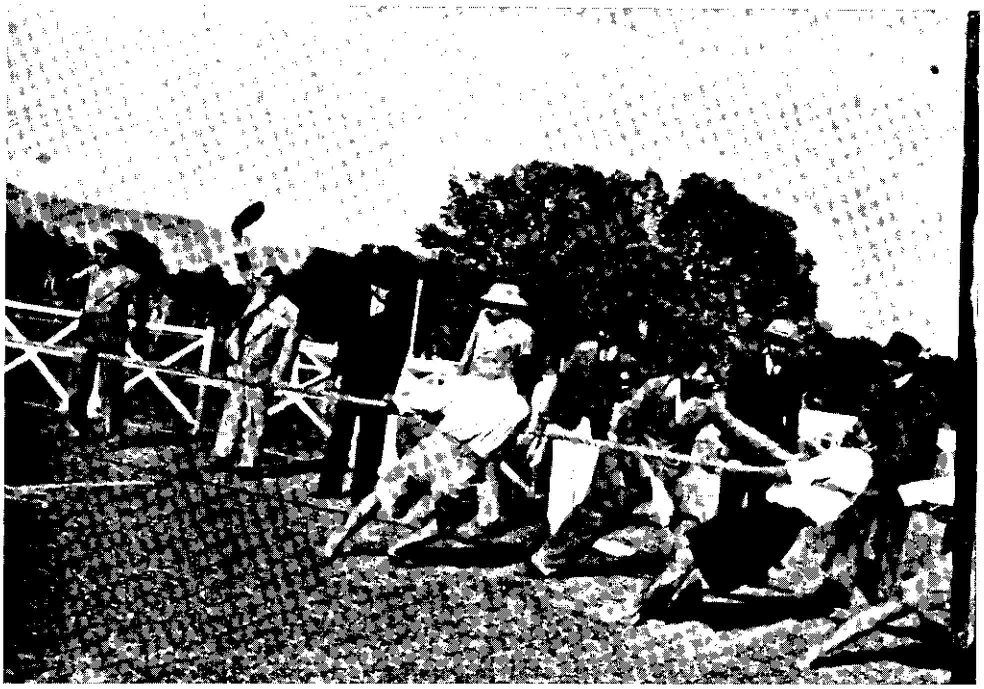
FOREST RESEARCH INSTITUTE AND COLLEGE ANNUAL SPORTS

For the past three years a combined athletic meeting of the staff of the Forest Research Institute and students of the Forest College has been held and it is hoped to make this an annual event.

In the main events preliminary heats were previously run off for the Institute and College separately to ensure that each was represented in the finals. This resulted in keen rivalry between the students of the College and the staff of the Institute. The students won the Tug-of-war but the Institute had their revenge in the Relay race.

The championship cup was won by Mohd. Azim, a student from Kashmir State.

Sir Gerald and Lady Trevor and the officers of the Institute and College were " At Home " to their friends and a very enjoyable afternoon was spent on the lawns in front of the Institute in what must be one of the most picturesque surroundings in India.



TUG-OF-WAR. SIR GERALD TREVOR JUDGING

SPAR FIGHTING

At the close of another successful meeting, the cups and other prizes were presented by Lady Trevor.

Results :

The names of successful competitors are given below :

Long Jump	.. M. S. Rana (F.R.I.), 1. Mohd. Azim (F.C.), 2.
Putting the Weight	.. Mohd. Azim (F.C.), 1. Muzaffar Ali (F.C.), 2.
Throwing the Cricket Ball	.. M. S. Rana (F.R.I.), 1. Mohd. Azim (F.C.), 2.
High Jump	.. K. Kerr (F.R.I.), 1. Mohd. Azim (F.C.), 2.
100 *Yards Race*	.. G. S. Rana (F.R.I.), 1. Mazeer-ud-din (F.C.), 2.
Hurdles	.. Mohd. Azim (F.C.), 1. K. Kerr (F.R.I.), 2.
Sack Scrimmage	.. Nurul Hasan (F.R.I.), 1. Mohan Lal (F.R.I.), 2.
220 *Yards*	.. G. S. Rana (F.R.I.), 1. Mazeer-ud-din (F.C.), 2.
Tug-of-war	.. Forest College.
Relay Race	.. Forest Research Institute.
Officers' Race	.. Mr. W. T. Hall (F. C.), 1. Mr. U. S. Madan (F.C.), 2.
Half Mile	.. Mohd. Azim (F.C.), 1. M. S. Rana (F.R.I.), 2.
Obstacle Race	.. Nurul Hasan (F.R.I.), 1. Mazeer-ud-din (F.C.), 2.
Spar-fighting	.. Ashaq Hasan (F.R.I.), 1. Lalji P. Ratnania (F.C.), 2.
The Forest Football Challenge Cup presented by Sir Alexander Rodger.	.. *Winners*, 1937. The Workshops (Forest Economist), F.R.I.
The Mason-Jaspal Cup	.. *Winners*, 1937—Timber Testing Section (F.R.I.).

R. K. Banerji Memorial Cup for Badminton. ..	*Winners*—Mr. K. Kerr. Mr. P. Zakaraya. *Runners-up*—Mr. A. L. Sabharwal. Mr. Pandit.
The Seaman Cricket Cup ..	*Winners*—Timber Testing Section (F.R.I.).
The Volley-ball Challenge Cup	*Winners*—F.R.I. team.

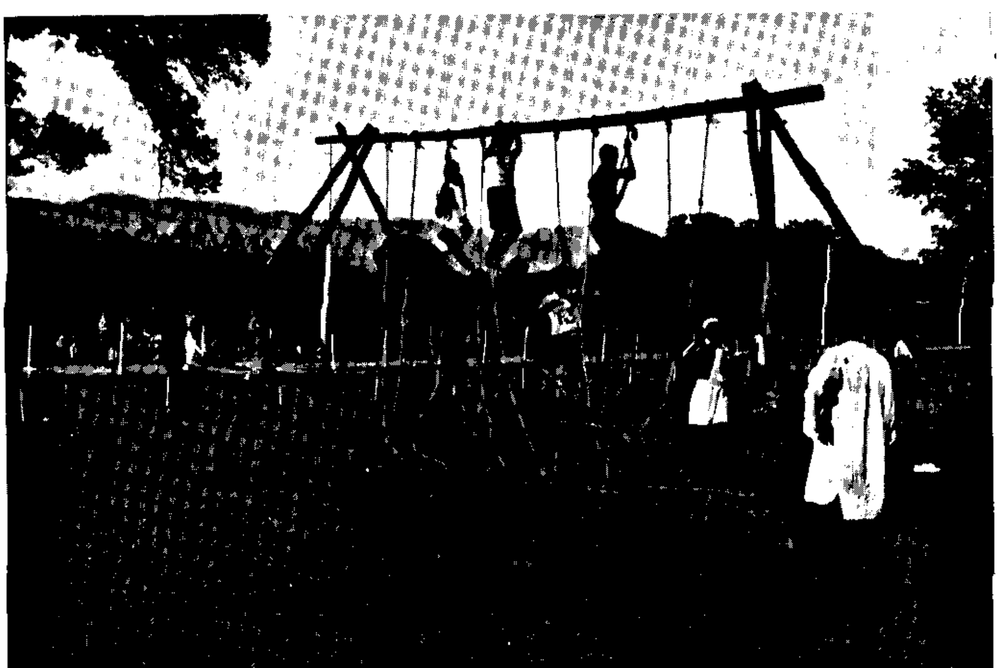
TENNIS.

Men's Open Singles (Cup presented by Mr. A. D. Blascheck). ..	*Winner*—Mr. Latifullah. *Runner-up*—Mr. Satya Karma.
Mixed Open Doubles (Cups presented by Sir Gerald Trevor). ..	*Winners*—Miss P. Trevor. Mr. A. L. Sabharwal. *Runners-up*—Miss G. Trevor. Mr. Kanji V. Govil.
Men's Open Doubles ..	*Winners*—Mr. Basir Ali. Mr. A. L. Sabharwal. *Runners-up*—Mr. Satya Karma. Mr. Latifullah.
Men's Handicap Singles ..	*Winner*—Mr. Basir Ali. *Runner-up*—Mr. A. L. Sabharwal.
Men's Handicap Doubles ..	*Winners*—Mr. Latifullah. Mr. Satyakarma. *Runners-up*—Mr. Basir Ali. Mr. U. S. Madan.

INDOOR GAMES

Auction Bridge ..	*Winners*—Dr. S. N. Kapur. Mr. Chattar Singh.
Chess ..	*Winner*—Mr. Mahboob Khan.
Ping-pong ..	*Winner*—Mr. Mahesh Prasad.
Carrom ..	*Winners*—Master Brij Nath Kapur. Master Ram Chandra Limaye.

OFFICERS' RACE



ONE OF THE OBSTACLES IN THE OBSTACLE RACE

THE YIELD IN TEAK SELECTION FORESTS IN BURMA

BY R. UNWIN, I.F.S., MAYMYO, BURMA.

Summary.—Attention is drawn to a contribution by "Sceptic" in the *Indian Forester* for September 1925 on the subject of the Burma Selection System. "Sceptic" expressed his conviction that the irregular teak selection forests were in reality normal in the sense that there is constant relation between the girth classes. Recent examination of enumerations in girth classes 3 to 6 feet and diameter classes 12 to 24 inches has shown that there is solid ground for "Sceptic's" belief and that allotment to sub-periodic blocks based on areas containing an equal number of stock 3 to 6 feet girth, or 12 to 24 inches diameter, gives in practice a much more equal yield than was obtained by the so-called Burma Method, which entails knowledge of survival percentages from class to class and of rates of growth. Actual results of girdling of a large working circle during the past 30 years are compared with enumerations of 1901—1904 to illustrate the point. Figures from another felling series show that 4 inch diameter classes from 12 inches up to 24 inches diameter are closely and constantly related and the writer deduces that this relation cannot conceivably hold good up to 24 inches only. In the belief that it holds throughout the range he uses the proportion of girdlings obtained in the past *in the same cycle* to calculate the yield in future. Control will, however, be by area containing equal numbers of stock 12 to 24 inches diameter.

In September 1925 there appeared in the *Indian Forester* a very interesting article entitled "Burma Selection System" by an anonymous contributor signing himself "Sceptic." The views expressed did not meet with unanimous approval as was shown by the reply in the same issue by "A Kitchen Gardener."

2. In the course of his article "Sceptic" said, "I have suggested that our teak forests are normal and that so long as we do not disturb the balance of nature we can rely on a sustained yield, but we have to take into account the fact that the girdling of a proportion of the seedbearers does to some extent disturb the balance of nature." "A Kitchen Gardener" took him to task about the word "normal," wrongly if I understand "Sceptic" aright, as the latter went on to say it was incumbent on us not only to maintain but ensure an increased yield. What "Sceptic" meant was that the forests were normally stocked *for the existing conditions* and would go on producing at the normal rate if the same treatment continued, *i.e.* "normal" was not used in the text-book sense.

The girdling of mature trees in a very rich teak forest may produce one tree *per* acre, but this is expectional and one *per* 3 to 5 acres would be nearer the average. In any case as was shown in the table of

enumerations in "Sceptic's" article the girdling of 5,000 out of 56,000 seedbearers need not materially affect reproduction. Even when an isolated tree is girdled there are often ungerminated seeds which can grow when the cover is removed and the soil is churned up during extraction operations. At any rate it is a widely accepted view that girdling and extraction do lead to an increase in regeneration. (A recent Madras plan mentioned that teak reproduction was good in those areas which have been worked over and poor elsewhere.)

3. The part of "Sceptic's" article with which the present notes are concerned, however, was the suggestion that the age (or diameter, or girth) classes remain constant. *Inter alia*, he wrote " . . . having by means of enumerations made an estimate of the growing stock in each compartment, to group a number of compartments together into coupes each of which is estimated to contain an equal proportion of the growing stock" and later on "If this assumption is justified, it follows that it is quite superfluous to make fresh enumerations at the beginning of each period. The compartments must be gone over in practically the same order and if the compartments have been grouped together so that each coupe yields approximately the same quantity of timber there can be no necessity for revising the coupes."

4. Dissatisfaction with yields calculated in terms of basal area (foreseen by "Sceptic" in 1925) led to a decision in 1933 to use other methods in Burma, and an attempt had to be made in 1934 to produce a large number of bricks with a very inadequate quantity of straw. Many plans were falling due for revision and the yields in others had to be recalculated. No money was available for re-enumeration and no Working Plans officers!

While casting around and examining figures of former enumerations, those made in 1925-27 of the Palwe Felling Series, Pyinmana Division, happened to come under scrutiny. The first 10 years of the 30-year felling cycle was just being completed. The forest has long been worked continuously, certainly since the sixties, and is one of the best in the Pegu Yomas. It is comparatively inaccessible,

except for extraction by water, and has never enjoyed any very great attentions in the way of improvement fellings, climber-cutting alone having been done with any regularity. Girdling was proceeding too rapidly and apart from refixing the yield the problem was to correct the allotment so that each coupe should contain an equal proportion of the exploitable stock.

The compartments had been girdled at intervals of 0 to 30 years before enumeration and calculation by the old Burma Method was not considered reliable enough in the absence of accurate figures of rate of growth and survival from class to class. It has been found wanting in case after case. A very good example recently came to hand in revising the plan for the North Pegu Division (old Nyaunglebin Working Circle). This plan, and the schedule of girdlings, expired in 1936. The results were as follows:

Sub-periodic block.	Enumerated stock of teak 3 to 6 feet girth on area allotted to sub-periodic block.	Number of girdled trees 7 feet and up obtained.	Proportion of stock to girdlings.
1	2	3	4
I (1906-15) ..	1,44,349	36,075	4·00 : 1
II (1916-25) ..	1,43,339	35,279	4·06 : 1
III (1926-35) ..	1,14,007	28,299	4·03 : 1

While allotment to sub-periodic blocks *on the basis of trees expected to reach the exploitable girth* was faulty, the *stock of teak* 3 *to* 6 *feet girth was a very accurate index of productivity!*

In the Plan for the Upper Thaungyin Reserves, where there is marked difference in the forests, some being very dry and some quite moist in character, results were available from 1915 to 1932.

Sub-periodic block.	Enumerated stock $1\frac{1}{2}$ to 6 feet girth.	Yield trees girdled.	Proportion of stock to girdlings.
1	2	3	4
I (1915-20) ..	50,819	6,665	7·63
II (1921-26) ..	1,01,519	13,270*	7·65
III (1927-32) ..	93,161	11,111*	8·38

5. Comparison has been made in several other cases and results all support the same conclusion. Naturally the proportion of stock to girdlings varies widely according to the class of forest, moist or dry, etc. etc., but provided reasonably homogeneous areas are taken together, allotment on the basis of stock 12 to 24 inches diameter, or in the older plans 3 to 6 feet girth, nearly always shows that a more equal annual yield would have been obtained than was actually the case by the older method. It was, therefore, decided to use the method for the Palwe Felling Series. Mr. M. N. Gallant, I.F.S., who did a good deal of work in this connection, had previously suggested elsewhere that one of the smaller 4 inches girth classes should be used as an index of productivity on the ground that it would not be interfered with by girdling and would be free from fluctuations due to regeneration occurring at odd intervals, thus perhaps causing fluctuations among the very small trees.

6. The 1925-27 enumerations of the Palwe Felling Series showed that the stock of teak on 96,942 acres was as follows (29·7 of the area was counted or rather more than usual in the past):

* Includes trees over the girth limit left standing under girdling orders. Prior to 1920 very few were so left.

Diameter Classes.

12 to 16 ins.	16 to 20 ins.	20 to 24 ins.	24 to 28 ins.	28 to 32 ins.	32 ins. and up.
1	2	3	4	5	6
1,27,451	1,02,943	67,759	36,155	16,782	14,779

Note.—If all trees 28 inches and up (7 feet 4 inches girth) were girdled at once, 31,561 trees, or about one to 3 acres would have been obtained (the girth limit is 7 feet 6 inches). On the other hand, seedbearers 12 inches to 28 inches would be about $3\frac{1}{2}$ to the acre (*vide* paragraph 2).

Since girdling of undersized trees down to about 6 feet girth (in the main) is done to remove deteriorating but marketable stems, the 24 to 28-inch class was ignored and only those 12 to 24 inches were considered.

The felling series contained 2,98,153 trees 12 to 24 inches and a list of compartments girdled since 1927-28 was prepared by extending the list until the compartments shown in it contained as nearly as possible one-third of 2,98,153=99,384. It was found that the first 39 compartments girdled contained 99,288 trees 12 to 24 inches and that the coupe thus determined was rather smaller than had been previously allotted and girdled. Further examination showed that the stock in the 39 compartments girdled was made up as follows:

12 to 16 ins.	16 to 20 ins.	20 to 24 ins.
42,769	34,756	21,763

whereas one-third of the total stock of these diameter classes in the felling series was:

12 to 16 ins.	16 to 20 ins.	20 to 24 ins.
42,484	34,314	22,586

7. As might be expected the whole class 12 to 24 inches shows the nearest agreement (99,288 compared with 99,384), but the close approximation of the figures in 4-inch girth classes is remarkable. At any rate in this felling series the number of trees in any diameter class is a measure of those in the other classes. It seems inconceivable

that this relationship should suddenly cease at 24 inches, or 28 inches, or even 32 inches diameter, provided conditions remain the same. In a virgin forest one would expect to find the number of trees 32 inches and up (roughly exploitable size) to be in constant relation to the lower classes and this should also hold good in a forest that has been exploited provided that girdling is done at equal intervals (*vide* "Sceptic's" statement in paragraph 3 above).

8. The Palwe Felling Series having been long under exploitation it has been found that the current round of girdling can follow, and is following, almost the same round as before so that each compartment will come for girdling after a 30-year interval (minor alterations scarcely affect the point). It was, therefore, decided (a new plan is now in the press) to divide the area into 10-year coupes each containing one-third, approximately, of the enumerated stock 12 to 24 inches diameter and to girdle the compartments in the same order as before, subject to minor adjustments to suit extraction.

Control will be by area containing stock of trees 12 to 24 inches diameter, *i.e.*, approximately 99,000 in each of the two remaining periods of 10 years in the felling cycle, but in order that the yield shall not vary from year to year, since it is not expected the forest is so uniform that 9,900 trees 12 to 24 inches diameter will produce the same outturn *per annum*, an annual yield in trees has been fixed for five years after which it will be reviewed according to the progress made. The actual number fixed is one that is in the same proportion to stock 12 to 24 inches diameter, as has been girdled during operations of the last 10 years.

9. There is sometimes a difficulty in fixing a steady yield in working circles where the girth limit is 6 feet 6 inches and 7 feet 6 inches in dry and moist forest respectively. Formerly, it was usual to fix a number of trees 7 feet and up, *i.e.*, the average girth limit, but this has been found unsatisfactory where there are large blocks of moist and dry forest to be girdled. In the first case almost every tree taken will count against the yield, whereas in the second a great many trees under 7 feet may be girdled to every one over 7 feet. (This cannot be corrected by allotting equal portions of dry and moist to each year

as extraction must in any case proceed round the drainages.) To avoid large fluctuations in tonnage the estimated number of trees available has, in a few plans, been converted to volume by using volume tables for two classes of trees, *i.e.*, 6 feet—6 feet 11 inches and 7 feet and over. Trees under 6 feet are neglected. The girdling officer continues till his 6 feet—6 feet 11 inches trees, multiplied by accepted volume, plus 7 feet and over trees, multiplied by accepted volume, approximately equals the tonnage fixed. Though at present results are few, calculations have been made from past girdlings to see how tonnage obtained is related, if at all, to stock of teak 12 to 24 inches diameter. The following figures are taken from the Nowin Felling Series, Prome Division :

Year of girdling.	Enumerated stock 12 to 24 inches diameter on area girdled.	Volume of trees girdled Tons.	Proportion Stock : Volume obtained.
1	2	3	4
1930-31 ..	11,288	9,964	1·13 : 1
1931-32 ..	11,531	10,245	1·11 : 1
1932-33 ..	8,860	8,355	1·06 : 1
1933-34 ..	10,493	10,072	1·04 : 1
1934-35 ..	13,680	12,033	1·13 : 1
1935-36 ..	9,277	10,381	1·12 : 1

It happens that in this forest dry and moist types are mixed up throughout the area and, therefore, the figures do little more than corroborate those given in paragraph 4 above.

10. Only time can show whether the assumptions are generally justified, but, so far, results are very encouraging. The great beauty of this method of control is that it does not depend on rate of growth,

or knowledge of survival percentages. Given reasonably accurate figures for stock made in former enumerations, it is possible to divide the forest into coupes of approximately equal productivity. If there are, in addition, accurate records of girdlings since the enumeration it is also possible to forecast the yield provided that past figures and girdling to be done both belong *to the same cycle*. Incidentally, the cost of such revision of plans is confined to an honorarium plus a little clerical assistance, whereas revision with enumerating parties in the past has in several cases cost over a lakh of rupees *per* division.

11. More difficulty is met when, though figures of earlier enumerations down to 3 feet girth or 12 inches diameter exist, the girdling is just beginning a fresh cycle. Up till recent times the yield included a proportion of the overmature and surplus trees which were removed in one or, sometimes, two cycles. At the beginning of a fresh cycle there is no experience in the new one upon which to base a forecast of the future yield. An attempt is being made to get over this obstacle, until results in the new cycle become available, by making use of trees 5 feet girth and over recorded as left by girdling officers since about 1921-22 when accurate records began to be kept. It is assumed that equal blocks of stock 3 to 6 feet girth, or 12 to 24 inches diameter will have had equal numbers of trees 6 feet and up left at girdling, and as this proportion can be fixed it is possible to estimate the numbers of trees 6 feet girth and upwards, which were left in an area containing one-third of the stock 3 to 6 feet girth, or 12 to 16 inches diameter, when the area was girdled 30 years before. By adopting the percentage of survival and rate of growth used in the earlier plan the number of these 6 feet trees expected to survive for girdling is estimated, and this is fixed as the yield for five years. The real control, however, will be that an area containing one-third of the stock must be girdled over in ten years.

12. There is no doubt that more scientifically-minded forest officers will throw up their hands in horror at such rough and ready methods and will doubtless point out that even if the smaller classes everywhere are in as close and constant relation as those mentioned in paragraph 6, there is nothing to show that these are "normal" or

that teak is not dying out or even increasing. Critics are asked to consider the special circumstances of Burma teak forests in which no yield is of any value save in the form of mature trees. Within limits the bigger the trees the more valuable they become and girdling limits are fixed more perhaps on market considerations than on silvicultural grounds. In 1907, by executive order girths were raised all round in the Pegu Yoma from 6 feet and 7 feet to 6 feet 6 inches and 7 feet 6 inches in dry and moist forest respectively and trees were to be girdled without regard to the yield fixed in the working plan. We may perhaps assume that present girths are if anything higher than is warranted by strict consideration of the length of rotation, rate of growth, etc. Few experienced officers would approve a general reduction in girth limits, though a good many consider that there is an appreciable loss by trees becoming overmature and unmarketable, while we are waiting for them to reach the limit. All that is being done over the vast majority of teak forests is, therefore, to remove trees just about to pass their prime, or already past it. To do more would be to throw extra supplies on a satisfied market (I refer to Burma as a whole and not to individual lessees) and to do less would be to cause loss by a higher percentage of unmarketable trees. Certainly we cannot be said to be overcutting silviculturally.

13. Fixation of yield then in this country is merely a matter of estimating how many acres can be cleared of mature trees annually, so that the outturn shall be approximately equal, without clearing too large or too small an area.

14. Since it is realised that more scientific calculation is desirable, it may be added that steps have been taken towards that end. Permanent sample plots to provide figures of survival from class to class have been started by the Silviculturist while every division is annually collecting additional figures for rates of growth by means of stump analyses. Figures for taper are also being collected to enable full use to be made of data collected from stumps.

From about 1921-22 teak trees 5 feet and up left at the time of girdling have been recorded by girth classes and from 1934-35 the record has been extended to include trees 4 feet and up. Moist and

dry forests are recorded separately. Since the normal girdling cycle is 30 years, it will be seen that figures for approximately half the teak forests are now available. The results are extremely interesting and when time permits it is hoped some more capable commentator may be persuaded to publish an account of them. In conclusion, a great deal more attention is being paid to natural regeneration than in the past. That attention is stimulated at the present moment by widespread flowering of the *kyathaungwa* (*Bambusa polymorpha*), an event to which we have looked forward since the days of Brandis, who recorded in his early notes on the Pegu Yoma that it had flowered generally in 1853.

JAK (ARTOCARPUS INTEGRIFOLIA, LINN.*) PLANTATIONS IN CEYLON

By W. M. McNEILL,

Divisional Working Plans Officer, Ceylon

Summary.—The cultivation of *jak* has formed an important part in the planting programme of the Ceylon Forest Department during the last decade. This note attempts to draw attention to the importance of the establishment of *jak* plantations and to summarize the silvicultural knowledge which has been acquired in this connection.

General. Without doubt the *jak* (*Artocarpus integrifolia*, Sinhalese: ***Kos***) is the most commonly planted tree and yields the most popular of all the home-grown timbers in Ceylon. It is to be found associated with permanent human occupation all over the Island but especially in that portion which lies between the wet low coastal belt, the dry flat country and the mountains. This district is frequently referred to as the Intermediate Zone and represents a peculiar vegetation intermediate or transitional between the wet tropical evergreen rain forest of the South and South-West, the dry evergreen forest of the North-West, North and East and the montane vegetation of the central mountain group.

This particular zone is not extensive. It is represented by a small area in the Province of Uva round Badulla, another restricted

*The specific name given by Alston in his supplement to Trimen's "Flora of Ceylon" is ***Artocarpus integra*** Merr. Int. Rumph. I have, however, retained the name used originally by Trimen which is the one most commonly used in Ceylon. For the same reason Trimen's names are used throughout this note for other Cyelon trees mentioned.—W. M. McN.

belt between the wet and dry Zones in the eastern portion of the Southern Province but its most extensive range is a rough triangle of approximately 190 square miles with Kurunegala (North-Western Province), Kegalle (Province of Sabaragamuwa) and Giriulla (North-Western Province) as the apices.

The altitude of this area varies from about 100 to 1,000 feet above sea level. Scattered hills are typical of the topography but the zone includes practically flat country as well as the foothills of the mountains.

The annual rainfall is between 75 to 125 inches but for the most part is round about 80. Rainfall is well distributed, and the benefit of both monsoon periods, *viz.*, South-West (May and June) and North-East (October and November), is felt.

The fact that the *jak* yields an edible fruit as well as a useful timber has accounted for its extensive distribution and its association with human habitation. The fruits are enormous globular structures frequently twice the size of a Rugby football and weighing many pounds. They are much prized by the villagers as food and both the large seeds and the pulpy material in which they are embedded in the fruit are used as an article of diet. The fruits are often given to cattle as a special delicacy and it has been suggested that if dried they might form a useful fodder. The timber is much in demand and always finds a ready sale so much so that well-seasoned material is hard to obtain. The wood is moderately hard and is a bright characteristic yellow colour when freshly felled but this soon darkens to a rich attractive brown. It is used extensively for furniture-making, planking, house-building, structural work and is generally employed for a great variety of purposes. Of all the timbers produced by Ceylon, *jak* is most likely to replace imported teak. The following figures are given by Unwin :

Weight	.. Average 40 lbs. per cubic foot.
Strength	.. Compression with the grain, 3·40 tons per square inch. Detrusion, ·30 tons per square inch. Modulus of rupture, 3·053 tons per square inch.

History.—The earliest records dealing with timber trees of Ceylon mention the *jak* tree. The Dutch used it extensively in their building and cabinet work and the earliest forest legislation introduced by the British attempted to protect this tree specifically from excessive and wasteful exploitation.

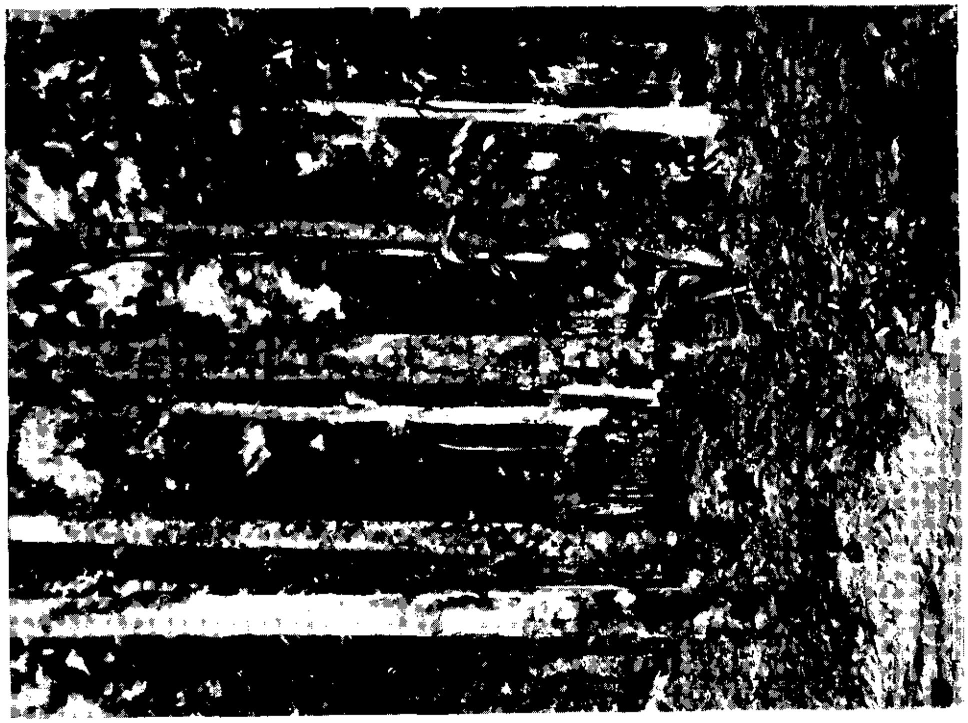
One of the most interesting facts about the *jak* is that, as far as is known, it is not indigenous to Ceylon. Two other species of *Artocarpus*—*Del* (*A. nobilis*) and *Kana-gona* (*A. lakoocha*) occur, the former being endemic, but although the writer has on a few occasions observed mature *jak* trees growing in natural forest in association with native species it is generally considered to be an introduced tree. So much so is this recognised that the presence of *jak* trees in forest or jungle is generally taken to indicate the site of previous human habitation.

In view of the facts outlined it is rather surprising to record that until comparatively recently no serious attempt was made by the Forest Department to grow this common and useful tree under systematic management.

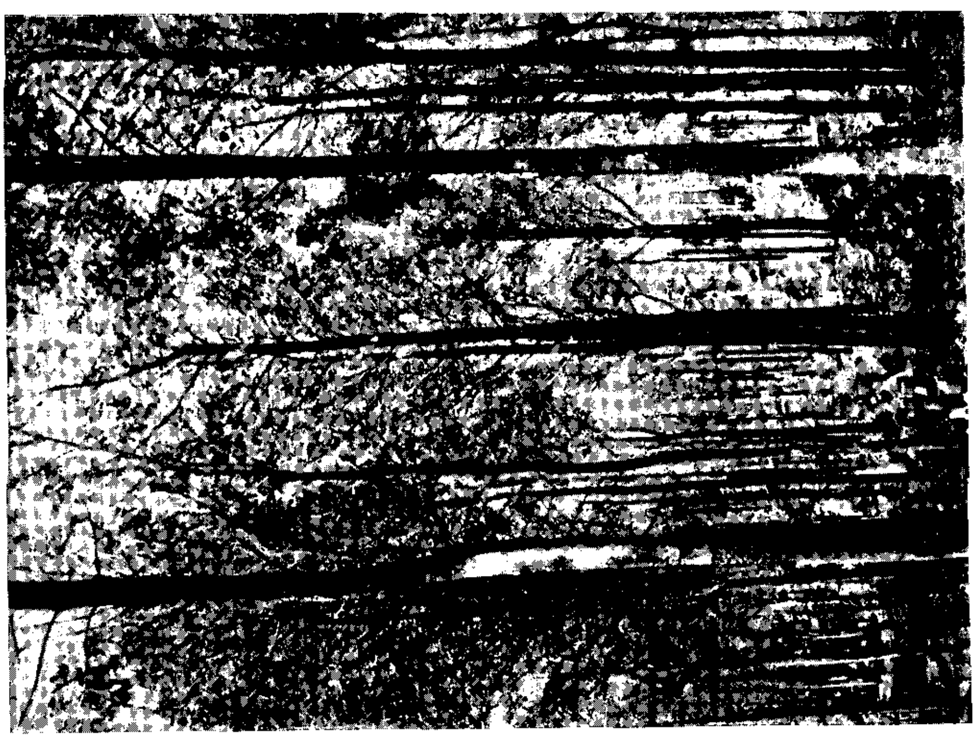
This is perhaps all the more surprising because as far back as 1896 some *jak* was planted in mixture with other species chiefly mahogany (*Swietenia macrophylla*), teak, *halmilla* (*Berrya ammonilla*), *milla* (*Vitex altissima*), etc., in one of the oldest plantations of the Department situated in Sundapola Reserve near Kurunegala, North-Western Province. The form, as well as the height and girth increment of these trees, was early noticed to be very satisfactory.

It was, however, only from 1922 onwards that an organized attempt was made to grow *jak* in artificially formed plantations and this note deals almost exclusively with the results obtained up to date in these plantations.

The first of the *jak* plantations were started in the North-Western Province within the triangle previously mentioned. They showed such promise at an early stage that, as frequently happens, the planting of *jak* became the rage and operations were started in numerous centres outside the Intermediate Zone before the silvicultural requirements of the species were anything like adequately



GROUP OF *Jak* IN MIXTURE WITH OTHER SPECIES. 30 YEARS OLD. SUNDAPOLA, NORTH WESTERN PROVINCE



Jak GROWN ON *chena* REFORESTATION SYSTEM IN INTERMEDIATE ZONE. 8 YEARS OLD. MARUKWATURA, KAGALLE DISTRICT, PROVINCE OF SABARAGAMUWA

understood. This hasty action led inevitably to failure in areas where climatic and other conditions were unsuitable and in turn produced criticism of the practicability of growing *jak* in plantations.

The knowledge which we now possess is the result of success and failure and is based on important positive and negative evidence. The writer does not claim that all problems connected with the systematic management of this species have been solved but he does claim that many acres of first-class *jak* plantations have been formed and that sufficient scientific knowledge has been acquired to make successful results with *jak* as reasonably secure as anything can be in forestry.

System of Management.—The system early evolved as the most suitable for *jak* cultivation is, what is called in Ceylon, the "*Chena* Reforestation System" which corresponds to the *taungya* of other countries. It is a combination of shifting temporary agricultural cultivation with the establishment of a permanent forest plantation. It is not intended in this note to deal very exhaustively with this system but as certain features of it are probably peculiar to Ceylon these will be briefly outlined.

Selection and, if possible, reservation of the area to be planted is the first step. This frequently constitutes numerous problems, for the district or zone proved to be the most suitable for the cultivation of *jak* is densely populated, extensively developed and suitable for permanent economic crops, all of which facts constitute counter-claims to the use of the land. Furthermore, Crown land is not very extensive in the best *jak*-growing district and remains now in scattered areas rarely of more than 500 acres in one compact block.

These forests have been largely exploited for saleable material but before any *chena* reforestation agreement is entered into a careful examination of the forest is made and any saleable timber extracted.

The next step is to enter into the planting agreement. This is done as a general rule at the end of the year to allow ample time for the agreement holder to clear, burn and fence his area before the break of the South-West rains—usually in May. The most

satisfactory time for sowing has been found to be the South-West Monsoon period. *Jak* seed is easily obtained and is supplied by the agreement holder. The seed is sown direct at intervals usually of 10 feet apart. (The question of the optimum planting distance and the question of mixture is still receiving attention and is dealt with more fully later in this note.)

The *chena* crops (*i.e.* the agricultural catch crops raised by this type of shifting cultivation) used in the locality most suitable for *jak* are brinjals, chillies, pumpkins and similar vegetables as a first crop and papaw and plantains as the main crop. A large variety of other food crops are raised occasionally and particularly in the districts less favourable for *jak*. These include cereals such as hill paddy, *kurakan*, etc., and very commonly in the areas of heavy rainfall manioc (*Manihot sp.*). Experience has shown that the most satisfactory area for any one agreement holder to manage is between 15 and 30 acres. Occasionally areas of 50 acres can be given with safety to men of exceptional reliability and financial stability.

By far the best results have been obtained by giving agreements to men of some wealth and influence. These men find their own labour principally from the neighbouring villages. The crops raised, especially papaw, are of considerable economic value and the successful accomplishment of the system both from the agricultural and forestry viewpoints necessitates financial outlay beyond the possibility of the ordinary villager.

This aspect of the system differentiates it from similar systems employed elsewhere. It is in some respects an unfortunate feature of the system and represents a departure from the original intention of the department which was that the villager of the cultivator class should be granted planting areas in his own name. Frequent efforts to do this have shown that it is not practicable.

It should be understood that *chena* cultivation in Ceylon differs from shifting cultivation elsewhere in so far as the cultivators remain in permanent fixed villages and carry out their cultivation within a distance of a few miles, at the most, from their permanent homes.

Owing to the popularity of this system, and the fact that it has now been continuously employed for over 10 years, it is usual for the Forest Department to select men from the list of proven and reliable agreement holders when fresh agreements are arranged.

At present a deposit of (usually) Rs. 5 per acre as security is made by the agreement holder before the agreement is entered into. This sum is refunded at the expiry of the term of the agreement if the work is judged satisfactory.

Various systems of rewards have been employed in the past and the writer personally favours some such system.

The usual period for which a *chena* reforestation agreement is current is three years. This is explained by the fact that such crops as papaw and plantain continue to be productive for this period.

The agreement holder is responsible for the care and maintenance of the forest crop during the currency of the agreement. This involves the replacing of vacancies when necessary, frequent weeding and removal of creepers, etc., and also the complete underplanting of the area in the last year—usually with mahogany (*Swietenia macrophylla*) 10 feet × 10 feet. Fencing, draining, pruning and all such operations are carried out by the agreement holder.

The area is in the charge of the Forest Department from the beginning and an agreement can be terminated at any time if work is unsatisfactory.

The usual system of supervision is to have a Forest Department overseer directly in charge of a group of areas, averaging about 700 acres. The overseers are responsible to the Forest Ranger of the range in which the plantations are located.

The system has worked remarkably well. Within the last ten years approximately 3,500 acres have been so established and the cost of formation to Government has been merely the supervision charges.

It has been found desirable to employ resident watchers on some of the plantations after the expiry of the agreements and maintenance charges have to be increased, but from the financial standpoint the system is most attractive.

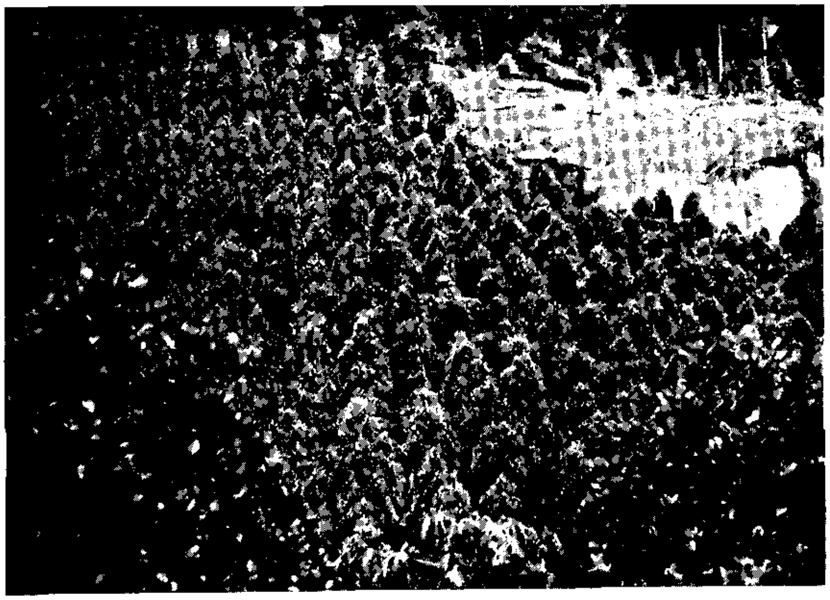
Important Silvicultural Considerations.—The locality which has been proved beyond all doubt to be the most suitable, in fact the only suitable one, for systematic *jak* cultivation supports a distinct forest association. It is, in the opinion of the writer, a climatic climax and represents a transition between the wet evergreen forest and the dry evergreen forest. By far the most important individual controlling factor is the rainfall. The Wet Zone has a rainfall of from 125 to over 200 inches. (The highest recorded mean during 19 years is 229·54 inches at Carney Estate, Ratnapura, Sab.). The Dry Zone has a rainfall of from 25 to 100 inches. The Intermediate Zone has a rainfall of from 75 to 125 inches.

The periodicity of the rainfall is also of importance in relation to *jak* cultivation. The most favourable distribution includes both the monsoon periods. The following figures for Ambanpitiya, North-Western Province, probably represent optimum distribution of rainfall:

Height above mean sea level, 663 feet.

Means of rainfall during 60 years.

Month.		Inches.	Days.
January	..	3·49	6
February	..	2·61	4
March	..	6·81	10
April	..	10·79	15
May	..	10·71	15
June	..	12·88	20
July	..	8·23	17
August	..	6·70	16
September	..	8·58	16
October	..	17·46	21
November	..	13·78	17
December	..	7·27	11
Total for the year	..	109·33	168
Greatest quantity registered in any 24 hours	..	16·65	August 7th to 8th, 1886.



Jak GROWN ON *chena* REFORESTATION SYSTEM IN INTERMEDIATE ZONE. 3 YEARS OLD. PUWAKMOTE, KEGALLE DISTRICT, PROVINCE OF SABARAGAMUWA

Jak GROWN ON *chena* REFORESTATION SYSTEM IN INTERMEDIATE ZONE. 8 YEARS OLD. *Chena* CROPS PAPAW AND PLANTAINS. NOTE EXCELLENT LEAF LAYER. PASPOLAKANDA, KEGALLE DISTRICT, PROVINCE OF SABARAGAMUWA

The natural forest vegetation of this climatic region or zone is, as might be expected, intermediate both in composition and quantity of species between the dry and the wet regions. Fewer species are found than in the humid evergreen rain forest and more species than in the drier evergreen forest.

Dipterocarps, typical of the Wet Zone, are either absent or rare, while ***Berrya ammonilla***, common in the Dry Zone, begins to appear. Several useful trees are found in this zone which are represented in both the Wet and Dry Zones. Typical of these is *Vitex altissima*.

Several species are more or less confined to this climatic region, the most important of which economically is *lunumidella* (*Melia dubia*). This tree which is an extreme light demander is not found in the climax. It is typical of abandoned *chena* land, and open clearings.

Among the trees occurring in the climax association of this locality the following are deserving of special mention: *wa* (*Cassia siamea*), *del* (*Artocarpus nobilis*) not so common as in the Wet Zone, *suriya mara* (*Albizzia odoratissima*), *hulanhik* (*Chickrassia tabularis*), *pehimbiya* (*Filicium decipiens*), *rukattana* (*Alstonia scholaris*), *goraka* (*Garcinia cambogia*), *muruta* (*Lagerstroemia flos-reginae*), *mora* (*Nephelium longana*), *katukenda* (*Scolopia acuminata*), *ratukekuna* (*Aluerites triloba*), *bulu* (*Terminalea belerica*), *kumbalu* (*Ailanthus malabarica*), *nigunu* (*Tetrameles nudiflora*), *sapu* (*Michelia champaca*), *kenda* (*Macaranga tomentosa*) and *nedun* (*Pericopsis mooniana*) usually found in moist sites and rarer than in the Wet Zone. This list is by no means exhaustive but includes most of the species considered typical of the association.

Luxurious undergrowth as well as epiphytes, creepers, ferns, etc., are not so common as in the wetter regions and the bamboo, *Ochlandra stridula*, so very common in the Wet Zone, is practically absent from the Intermediate Zone. *Lantana* and *Mimosa pudica* are common in clearings and the troublesome exotic creeper ***Mikania scandens*** is only too prevalent. This latter species is very troublesome and frequent weedings are necessary to keep it in check in the younger plantations,

In composition the soils of the Intermediate Zone vary very little from those of other parts of Ceylon. They are typically lateritic red earths or red loams formed usually by the decompositions of gneisses *in situ*. The laterisation process is generally speaking only partial. An average example of the soil of the district where *jak* has been most successful is afforded by the following notes and figures recorded by Dr. A. W. R. Joachim of the Department of Agriculture :*

"RED SEMI-HUMID FOREST SOIL PROFILE.

Location	.. Sundapola Forest, about 4 miles from Kurunegala.
Elevation	.. 350 to 400 feet.
Climate	.. Rainfall, 85 inches (approx.); temperature, 80° F. (approx.).
Geological origin	.. Basic and intermediate gneisses.
Mode of formation	.. Residual.
Drainage	.. Good.
Topographic position	.. Slightly undulating; sample from lower end of gently sloping hillside.
Vegetation	.. Forest, *jak*, mahogany, teak, satin and *lunumidella*.

PROFILE.

A1. 0 to 12 inches	.. Yellowish-grey loam; upper 2-inch brownish black humic layer; coarse granular to nodular; some ferruginous and quartz gravel; compact when moist but friable; porous; roots abundant; acid; horizon boundary fairly distinct.
A2. 12 to 18 inches	.. Reddish-grey brown compact loam; ferruginous quartz fairly abundant; irregular clod; hard when dry but friable; porous; root growth good; acid; horizon boundary not very distinct.

* "Studies on Ceylon Soils," A. W. R. Joachim, Ph. D., and D. G. Pandittesekera, "The Tropical Agriculturist," Vol. LXXXV, No. 1, July 1935.

C. 18 inches to 4 feet .. Reddish-yellow heavy loam with abundance of quartz and ferruginous gravel; fairly compact; porous; irregular clod; mottled yellowish red due to decomposing ferruginous concretions; roots rare, lateral roots absent; acid.

Mechanical Analysis.

	A1.	A2.	C.
	Per cent.	Per cent.	Per cent.
Stones and gravel	10·5	31·4	51·0
Coarse sand	49·4	49·8	51·7
Fine sand	17·3	17·7	8·0
Silt	4·7	4·8	5·5
Clay	20·4	20·7	32·4
Loss by solution	0·5	0·5	0·4
Moisture	7·7	6·5	2·0
Texture index number	19·0	19·2	29·9
Soil type	Loam	Loam	Heavy loam.

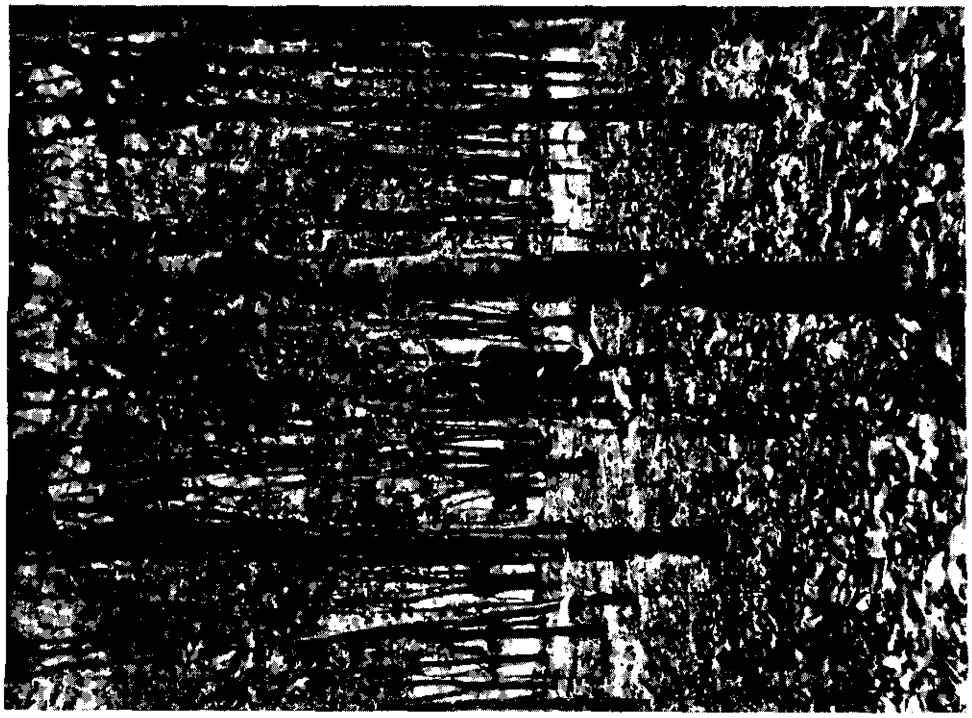
Chemical Analysis.

Loss on ignition	5·17	4·69	5·34
Organic matter	1·82	1·23	0·42
Combined water	3·35	3·46	4·92
Carbon	1·06	0·71	0·24
Nitrogen	0·160	0·119	0·085
Carbon/nitrogen ratio	6·59	6·00	2·00
Reaction	5·6	5·8	6·2
Total lime	0·156	0·135	0·129
,, potash	0·092	0·113	0·086
,, phosphoric acid	0·047	0·049	0·044
Total exchangeable bases (m.e. per 100 gm. soil)	7·78	6·17	6·05
Exchangeable calcium	6·30	4·82	5·10

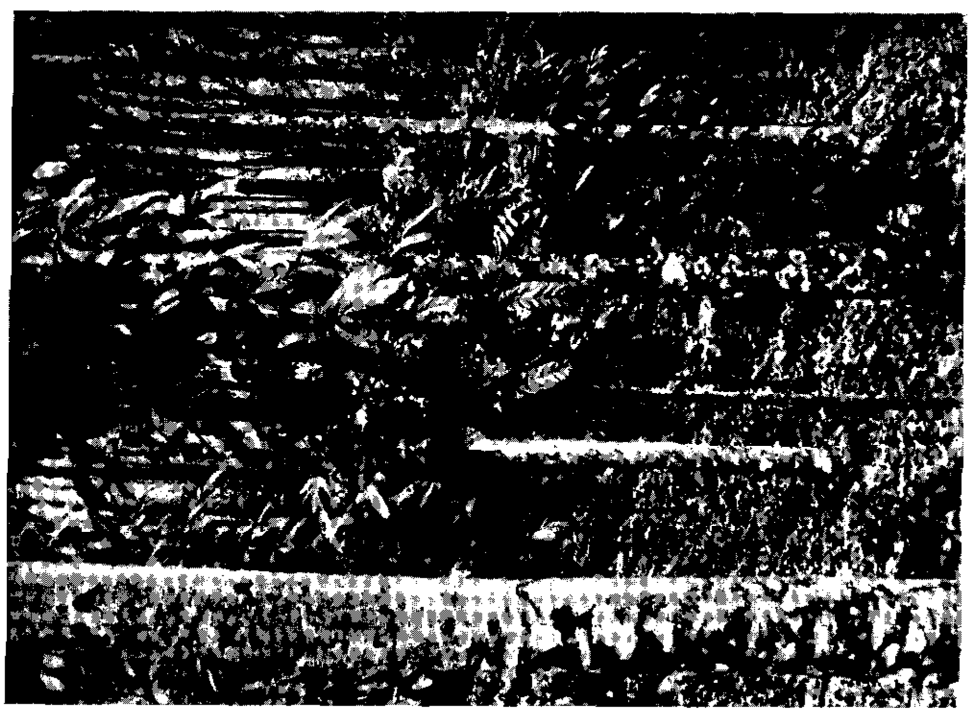
Clay Analysis.	A1. per cent.	A2. per cent.	C. per cent.
Loss on ignition	21.40	..	..
Silica ($Si\ O_2$)	43.60	..	..
Sesquioxides ($R_2\ O_3$)	54.24	..	..
Alumina ($Al_2\ O_3$)	38.80	..	..
Iron oxide ($Fe_2\ O_3$)	15.44	..	..
$SiO_2/Al_2\ O_3$ (molecular)	1.90	..	..
$SiO_2/R_2\ O_3$,,	1.52	..	..
Soil type	Lateritic to non-lateritic.		

The Kurunegala forest soil is similar in many respects to the forest soils of the humid south-west low-country. The B horizon is absent. The A horizons are medium loams, while the C horizon is heavier in texture. There is all through this profile an abundance of quartz and ferruginous gravel which makes for good drainage. The gravel percentage increases appreciably with depth. The organic matter contents are low even in the A1 horizon, but the nitrogen contents are fair. The C layer is very deficient in carbon but has a fair reserve of nitrogen. Carbon/nitrogen ratios therefore vary from 6·6 in the A1 horizon to 2 in the C horizon. The soils are acid in reaction, the acidity diminishing slightly with depth. They are much below the average in total mineral nutrients, but the total exchangeable base contents are fairly high, being in fact the highest noted in local humid and semi-humid soils. Calcium is over 80 per cent. of these bases. The clay analysis of the A1 layer reveals a fairly high sesquioxide and a fairly low silica contents. Iron oxide constitutes 15·4 per cent. of the clay fraction and alumina 38·8 per cent. The soil on Martin and Doyne's criteria is just lateritic verging on the non-lateritic type. It answers in many particulars to Hardy's tropical red loams. The soil appears to be well adapted for forest growth and a number of valuable forest species flourishes in the area."

The local variations in both the physical and chemical characteristics of the soil have been found to be of importance in the cultivation of *jak*. The species definitely demands the richer soils and cannot be established on soils from which plant nutrients are deficient either



Nedun PLANTED IN LOW-LYING GROUND. 12 YEARS OLD. AV. HT. 34 FT. AV. GIRTH 14 INCHES. BADAGAMUWA, KURUNEGALA DISTRICT, N.W.P.



Jak GROWN ON *chena* REFORESTATION SYSTEM 10'×10'. 8 YEARS OLD. THINNED ONCE. UNDERPLANTED WITH MAHOGANY. 5 YEARS OLD. *Jak* AV. HT. 33 FT. AV. GIRTH 21 INCHES. DAWATAGOLLA, KURUNEGALA DISTRICT, N.W.P.

as the result of leaching, erosion or the root competition of other species. This fact is closely connected with the failure of *jak* in the areas of heavy rainfall where the soil is exposed to heavy precipitation after the forest has been cleared. It also accounts for the difficulty of establishing *jak* on the tops of hills or on steep hillsides where the surface soil is very largely composed of particles of quartz.

The poor growth of *jak* when grown with manioc as the principal *chena* crop is most probably explained in terms of soil nutrients. In addition to a tendency to cause suppression manioc is an exhausting crop. Not only does it remove large quantities of plant food from the surface layers at a time when it is important that these should be available for the *jak* but the tubers are dug up and removed thereby precluding any chance of the nutrients becoming available later. Manioc is grown almost exclusively in the districts of heavy rainfall and the loosening of the soil resulting from the up-rooting of the tubers further impoverishes the soil by leaching and erosion.

An examination of the soil is important in dealing with the cultivation of *jak* and several mistakes could have been avoided in Ceylon if this factor of the environment had been more closely studied. At the same time such unsuitable edaphic conditions are usually of restricted extent and for the most part the forest soils of the semi-humid region are very suitable for *jak* cultivation. Careless management can often reduce suitable to hopelessly unsuitable soils and the maintenance of soil cover and soil protection plays no small part in the successful establishment of *jak* plantations.

As regards the actual cultivation of the *jak* crop and the establishment of successful plantations experience has proved several very important facts. The selection of cultivators, if the *chena* reforestation system is employed, and the choice of suitable environment have been touched upon. Within the congenial climatic region itself careful examination of the site is well repaid. Damp water-logged areas or situations liable to be flooded should be avoided. Poor quartz soils should not be planted. It is much better to leave these uncleared but when these are met with after clearing it has been found more suitable to plant them with *Vitex altissima* than with *jak*. In the

same way shallow soils with slab rock near the surface should not be planted.

Having selected the site with care, management is much simplified but certain very necessary precautions have to be taken. It has become axiomatic in *jak* cultivation in Ceylon that success depends on the early establishment of the forest crop. The importance of getting the seed sown at the commencement of the first rains after clearing and before the catch crops are sown cannot be overstressed. Late sowing results in the seedlings not being properly established before the dry weather sets in. There seems to be little doubt that *jak* requires in its early stages plentiful supplies of soil nutrients such as are found only in sufficient quantity in the upper layers of the soil. If sowing is delayed either the food crops have appropriated this available nutrient or it has been washed away, or both, and successful establishment is often impossible in areas which could have been successfully stocked.

In the past it has been the general practice to sow two or more seeds at the selected intervals as an insurance against poor germination or subsequent damage. Opinion is divided on the advisability of such a practice. If all except one seedling are removed as soon after germination as possible probably little damage is done and there is doubtless a better chance of complete stocking. The seed is cheap and easily obtained but the extra labour in removing extra surplus seedlings has to be remembered. In the opinion of the writer the sowing of one single seed at a spot marked by a small peg or stake if done at the proper time and in the proper site has very definite advantages. Germination of freshly collected seed is excellent. Soon after germination the seedling becomes dependant on soil nutrients. If more than one seedling are competing for the limited soil nutrients available in the vicinity of the sowing spot the vitality of all seedlings is reduced. If damage is likely to take place after germination the chances are that all seedlings will suffer.

Sowing is considered preferable to planting. Nursery transplants have been used but they are not so successful as seedlings raised by direct sowing. The high percentage of germination and the necessity

for early establishment, quite apart from simplicity and economy, all favour direct sowing. Various degrees of spacing have been tried, especially 3 feet × 3 feet, 5 feet × 10 feet and 10 feet × 10 feet. The latter is now generally employed but it is questionable if the interval could not be extended still further. Close spacing results in early crowding and in a general lowering of the strength of the individual plants. If properly established, *jak* grows rapidly in the first five years and it has been found necessary to thin plantations sown 10 feet × 5 feet at the end of three years. As the presence of the *jak* naturally interferes to some extent with the raising of *chena* crops it is important to find the most profitable combination of the two. This is especially true when the *chena* crops are comparatively tall plants, such as papaw or plantain, for the young *jak* seedlings must not be over-shadowed or suppressed, once they have reached a height of 12 or 18 inches.

Normally, sufficient lateral shade for the *jak* in the early stage is supplied by the food crops, but if this for any reason is deficient it may be desirable to shade the *jak*.

The question of mixture is one which requires further investigation. Most of the plantations were started as pure *jak* and there is ample proof that an unmixed stand can be well established but, for silvicultural as well as economic reasons, some form of mixed crop is probably advisable.

The importance of soil cover has been mentioned and it is now the general practice to underplant the pure *jak* crop with the large leaved mahogany. This is done at the end of the third year. A start of three years for the *jak* is probably sufficient provided it has been sown at the correct time. Actually in the best plantations with a spacing of 10 feet × 10 feet the *jak* crop closes quickly and develops such a good canopy that by the end of the fifth year the soil is well protected and the forest floor is kept very clean.

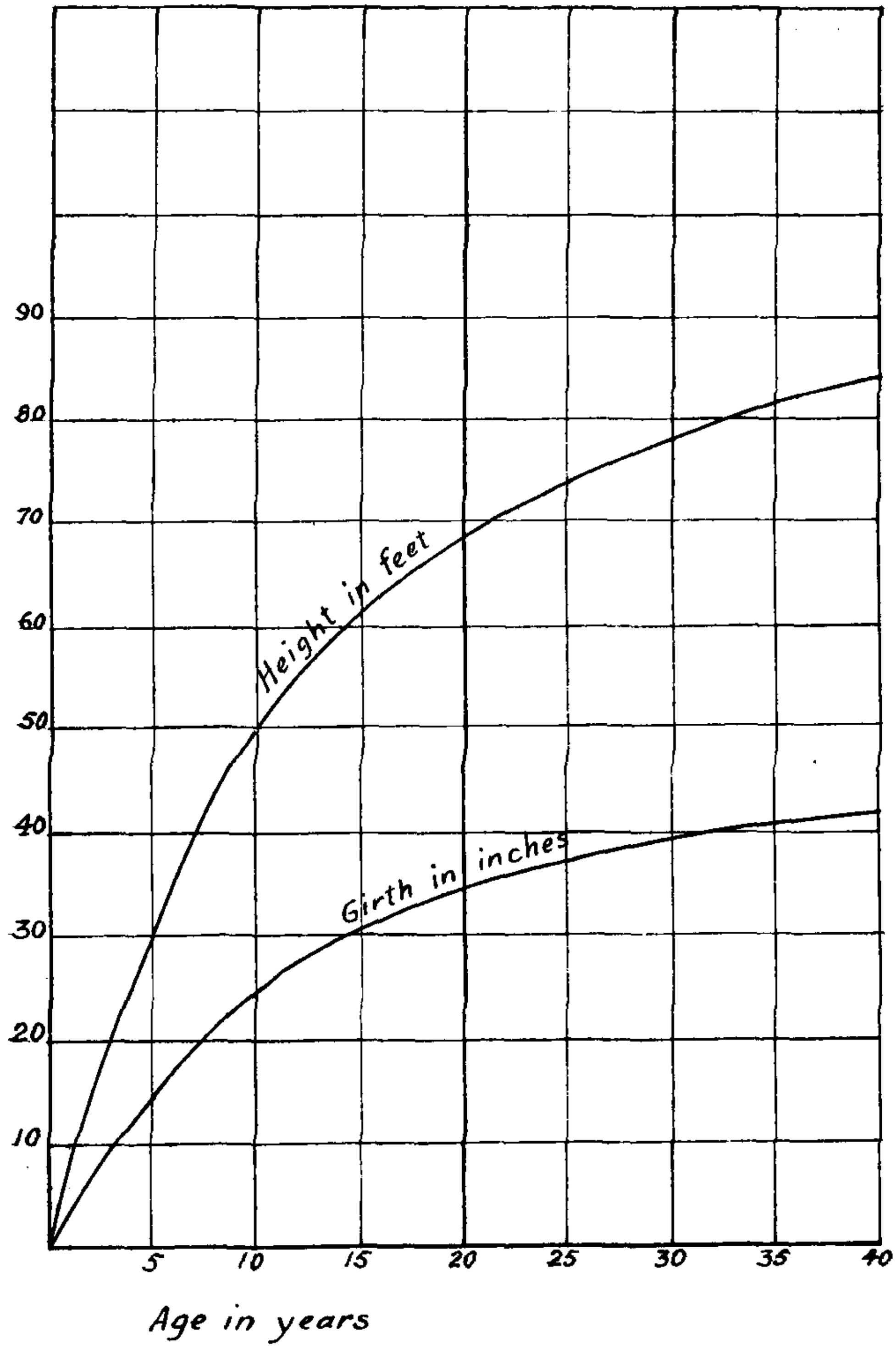
Underplanting is really only necessary as a soil protection in the case of open plantations but the mahogany can stand a lot of shade and is a valuable alternative species. The mahogany is usually raised in nurseries from seed supplied by the Forest Department and

is planted out either 10 feet × 10 feet or 20 feet × 20 feet by the *chena* agreement holders before the area is handed over by them. The cost of underplanting is therefore very small.

Nursery-raised basket plants of mahogany have been found to be the most successful and this method is used where possible but considerable success has been obtained by the direct sowing of mahogany or with transplanted natural seedlings.

A mixture which has already yielded very good results and which is likely to be increasingly employed is a combination of *jak* with *lunumidella* (*Melia dubia*). The latter is very fast growing and is much in demand for sheeting, ceiling boards, box-making, boat-building, etc. This species is, moreover, practically confined to the same zone as *jak* and it is generally true that where one species will succeed so will the other.

The most successful combination so far evolved, and the results are remarkably good, of *jak* and *lunumidella* is the sowing of *jak* 10 feet × 10 feet and the planting of *lunumidella* stump plants 40 feet × 40 feet. The germination of *lunumidella* is uncertain and results with stumps from nursery-raised seedlings or natural regeneration are very satisfactory. Both species are either put in at the same time or the *lunumidella* one year after the *jak*. The *lunumidella*, being very fast-growing, soon out-tops the *jak*. It is, however, deciduous during the hot weather between the monsoons—February to April and August to September—and even when in leaf casts such a light shade that it causes practically no suppression to the *jak*. So rapidly does it grow that in some cases it has been possible to fell the *lunumidella* for timber after the tenth year and the general plan of management provides for the sale of the *lunumidella* crop at the end of the fifteenth year. By that time the *lunumidella* has an average diameter of about 2 feet and an average utilizable bole of about 30 feet. The profits from such a mixture at this stage of the rotation are obvious. Care is necessary in felling the *lunumidella* to avoid damage to the *jak*. This has been accomplished by requiring the *lunumidella* to be lopped before felling, an operation rendered possible in the intensive system of management employed. *Lunumidella* has



GRAPH OF HEIGHT AND GIRTH OF *Jak*.

practically no soil protective value and in the case of the mixture described the underplanting of mahogany is also carried out.

In such a method of planting as that under review it is possible to carry out operations which would be impracticable in a less intensive system. In addition to the choice of mixture the selection of species in relation to the site can be carefully considered. Low-lying damp areas are not planted with *jak* but are planted with the endemic *nedun* (*Pericopsis mooniana*), a species much prized for its beautiful timber used for cabinetwork. Nursery-raised plants are put out usually 6 feet × 6 feet in such sites and, if necessary, preparatory draining is done by the *chena* agreement holders.

Milla (*Vitex altissima*) is planted at close intervals on hilltops, ridges and sites where the soil is too poor for *jak* but this species, though providing excellent timber, exhibits very poor tree form necessitating heavy and frequent pruning and it is questionable whether on sites unsuitable for *jak* the best method is not to leave the natural forest uncleared.

There is a definite relationship between the growth of *jak* and the particular *chena* crop grown. Experience has shown that a tall crop, such as papaw or plantain, is preferable to a low one such as manioc. Still more important is the amount of plant food removed from the soil by the agricultural crop. A root crop like manioc is very exhausting and reacts detrimentally on the *jak*. Only the fruit of the papaw (this is tapped for papain) and plantain is removed and the plants are allowed to die and return to the soil after the third year.

The immaturity of most of the existing *jak* plantations make it difficult to lay down with certainty any thinning plan. It is, however, already obvious that early thinnings are most desirable. The present system is to thin the first class plantations at the end of the fifth year. This of course depends on the closure of the canopy and may have to be deferred in the case of open plantations but, with the system of planting now employed, the crop is generally ready for a 50 per cent. removal of stems when six years old. Owing to the very regular condition of the plantations an almost mechanical thinning can be done.

It would be interesting to see if the silvicultural methods recently advocated with great conviction for wattle growing in South Africa would yield beneficial results in the case of *jak*. With a well formed plantation early thinnings are clearly advisable but possibly the initial sowing interval could be extended with advantage.

Injuries to which the crop is liable.—Apart from the silvicultural requirements of *jak* there are a number of precautions which have to be taken to ensure protection against damage to the crop.

During the young stages and particularly during the first year *jak* is very susceptible to damage by a variety of animals.

Unless protected it is severely browsed by cattle, goats and deer. In the vicinity of villages and in the comparatively developed part of the country most suitable for the cultivation of *jak* damage by cattle may be serious. In addition to browsing serious damage is caused by trampling by buffaloes and village cattle. The consequent hardening of the soil early results in a slowing down of increment, poor crown development, and the intrusion of grass.

The only way to protect plantations against damage by cattle is to keep the areas carefully fenced.

Serious damage may be caused by hare which are very fond of the young shoots following germination. Where this cause of damage is prevalent areas have to be protected by wire netting.

In some cases monkeys have damaged the young plants by breaking off the tender shoots.

Among other animals which have been known to cause damage are rats which eat the seed and porcupine which gnaw the bark.

It is unwise to grow *jak* in localities where wild elephants occur as these animals are exceedingly fond of both the leaves and fruits. Fortunately in Ceylon elephants are not found in the district most suitable for *jak* cultivation.

Serious damage may be caused both to the *jak* and still more to the *lunumidella* by the Kalutara Snail (*Achatina fulica*). The bark of the young plants is eaten by these snails which frequently girdle the

stems. The best way of coping with this pest is to collect the snails at night with the help of a light and destroy them. Heaps of rubbish are breeding grounds for these snails and should be burnt.

A few cases of defoliation by the larvæ of a moth (*ocinara varians* Wlk. Family, *Bombycidæ*) have occurred but the resulting damage has been slight and the larvæ are eaten in large quantities by birds, principally the Mynah (*Acridotheres tristis melanosternus*).

More serious is the susceptibility to attack from the root fungus *Fomes lignosus*. Although this fungus is so far not very common in *jak* plantations trees up to 40 feet in height may be killed. The best method known of dealing with such attack is to uproot the infected tree, burn it and isolate the place of infection by digging a trench 2 to 3 feet deep round it.

This enumeration of enemies of the *jak* may at first sight appear rather formidable but none of the dangers mentioned need, in the conditions under which *jak* is grown on the *chena* reforestation system, be of any serious importance. Practically all the damage which is likely to occur takes place in the first three years of the life of the crop and during this time the plantations are under careful and concentrated attention by the cultivators.

Statistics of growth and yield.—The following table which shows the average girth and height of *jak* up to an age of 40 years has been compiled from measurements taken of all trees in average plantation lines in 16 different plantations. Over 4,000 trees were thus measured and the figures given may be regarded as a fair crop average. The credit for this work belongs to Mr. K. P. Rajalingam, Extra Assistant Conservator of Forests.

Age in years.	Girth in inches.	Height in feet.
10	24	50
20	34	69
30	40	78
40	42	84

Recently a number of permanent sample plots have been laid out but figures are not yet available from them. It is hoped to obtain useful information from these plots regarding the optimum times for and degrees of thinning.

From figures available it appears that the most suitable rotation would probably be between 60 and 70 years.

Conclusions.—From what has been stated in this note it seems reasonable to draw the following conclusions:

(1) *Jak* is a most desirable tree to grow in Ceylon on account of the popularity and excellence of its timber and, to a less extent, on account of the production of edible fruit.

(2) The climatic and other conditions suitable for the establishment of *jak* plantations are limited. In Ceylon the Intermediate Zone has been found to provide the most favourable conditions for the successful establishment of *jak* plantations.

(3) A co-operative system combining forestry with agriculture (*chena* reforestation) has been proved by experience to be very satisfactory as a method of creating concentrated stands of *jak*. Such a system has definite economic advantages.

(4) Provided precautions are taken regarding choice of locality and site, methods of survey, selection of cultivators and control of management, complete success can be reasonably assured.

(5) A mixture is preferable to a pure crop of *jak*. Species that have been found suitable for mixture with *jak* are *lunumidella* (*Melia dubia*) and the large-leaved mahogany (*Swietenia macrophylla*).

(6) Available statistics of growth and yield indicate that large-sized *jak* timber can be economically grown in Ceylon.

EXTRACTS

Address Presented to His Highness Sri Krishnarajendra Wadiyar Bahadur, G.C.S.I., G.B.E., Maharaja of Mysore, on the occasion of Laying the Foundation-stone for the Factory Buildings of the Mysore Paper Mills, Limited, at Bhadravati on the 1st April 1937

MAY IT PLEASE YOUR HIGHNESS,

We, the Chairman and Directors of the Mysore Paper Mills, Limited, humbly beg leave to submit our most loyal and heartfelt gratitude to Your Highness for graciously agreeing to lay the foundation-stone of our factory buildings.

Our Company owes its existence to the far-sighted statesmanship and generous encouragement of Your Highness' Government. So long ago as 1914, Your Highness' Government directed the conduct of investigations into the bamboo pulp resources of the State, as an item in the programme of the economic development of the State and the improvement of the outlying malnad areas.

The fruition of this scheme, however, was delayed till now for lack of cheap electricity at Bhadravati, which was found to be the most suitable site for the location of a paper factory. With the extension of hydro-electric power to Bhadravati early last year, this difficulty disappeared and the Government sanctioned, on the 29th April 1936, the establishment of a paper factory at Bhadravati as a joint-stock concern and generously extended various facilities and concessions to the Company.

Your Highness' Government have subscribed ten per cent. of the capital of the Company and have given free of cost the land required for our purpose.

The extension of the tramway and meter gauge lines of the Mysore Iron and Steel Works to the Paper Factory, the arrangement for the haulage of wagons and affording of workshop and other facilities by the same works and the promise of medical and educational amenities to our staff by the Government, afford immediate advantage to the Company.

The assured supply of bamboos at a fixed price of Rs. 12 per ton delivered at the factory sidings, and the assured purchase by the Government to the extent of their requirements of the paper manufactured by the Company places us in a relatively safe position as regards the future.

We crave permission to express publicly on this occasion our deep sense of gratitude to Your Highness' Government for their benevolent encouragement and particularly to our respected Dewan, Amin-ul-Mulk Sir Mirza M. Ismail, to whose enthusiasm for, and personal interest in, the economic development of the State our Company owes its creation.

Our plant is designed to manufacture 4,500 tons of paper a year, valued at nearly 16 lakhs of rupees. The factory will pay to the Government more than a lakh and a half of rupees a year for bamboos and about two lakhs of rupees for electricity. The Mysore Railways will gain 15,000 tons of new traffic in coal, paper and other materials every year.

The factory will provide subsistence for 800 families or 4,000 souls, not including labour that will be employed by the Forest Department for the extraction of bamboos. A lakh and a half of rupees will be paid annually in salary and wages.

The establishment of this factory will further provide a means of making money from waste materials. By conserving rags and waste paper and selling them direct or through collectors to the paper mills, every householder in the State can help himself and help the mills. The village *panchayats* also have in this, and in collecting scrap iron and steel for the Mysore Iron and Steel Works, a useful new line of activity and can help the villager to make a few annas while getting rid of his refuse.

We beg leave to take this opportunity to bring to Your Highness' gracious notice the valuable help rendered to the Company by Mr. M. P. Bhargava of the Forest Research Institute, Dehra Dun, by his scientific advice and by Rajamantrapravina Diwan Bahadur K. Matthan, the first Chairman of the Company, by his able pilotage in the initial stages.

Your Highness' gracious presence to-day is of happy augury to us, and proves Your Highness' abiding solicitude for the success of all activities undertaken for the material development of the State.

We now humbly beg Your Highness to graciously lay the foundation-stone of the Mysore Paper Mills, and confer on our enterprise Your Highness' benign blessings.

May this factory fully justify the hopes entertained by the Government and the public of this State and help in ameliorating the conditions of this malnad tract, and may it ever continue to steadily inspire the increasing development of industrial enterprise in our beloved land, is our ardent prayer to God Almighty on this auspicious occasion.

In conclusion, we beg to express our profound sense of loyalty and devotion to Your Highness' Royal Person and House.

THE USES OF LAMINATED VENEER

Natural wood has many qualities rendering it desirable as a material, but also various disadvantages, such as varying strength and the tendency to shrink and swell. These unfavourable properties of wood in its natural state operate in many instances to impede its use. For this reason, efforts have for long been directed towards producing, from natural wood, a semi-artificial material free from these drawbacks. One of the results has been plywood, which shows better properties in the respects mentioned. The possibilities of utilizing plywood are, however, restricted, inasmuch as it can be made only in sheets of limited dimensions.

It is with a view to avoiding these limitations that laminated veneer was created. Laminated veneer may be produced from a great variety of woods, all countries growing timber suitable for the purpose.

As will be seen from the description to follow, the principle of manufacture is extremely simple. Its application, however, calls for an accurate understanding of the technological properties of wood *and for the proper use of suitable machine equipment.*

A log, in the condition it comes from the forest, is cut into about 1,000 mm. (3¼ feet) lengths. Thereupon the sections are deprived of the bark and at the same time rounded on a pre-turning lathe. This pre-turned log is next steamed, and then clamped in a special machine charged with converting it into a continuous band or ribbon of uniform thickness. This band runs on to a drum, together with an *intermediate* ribbon, which is saturated with a preservative for protecting the veneer ribbon against mildew and uneven drying. The winding-on process takes place automatically.

The charged drums are now passed on to a second machine, the so-called doubler, the duty of which is to combine the single veneer bands under the application of pressure and heat. This is done by running the bands from the drums in pairs over a conveyor belt, together with a third band taken from a stack, and passing them through a drying, impregnating, and gluing machine. The bands so

joined into the laminated veneer, which now possesses a higher longitudinal and transverse strength than the original wood, are reeled on to spools to serve as material for a great variety of uses. To this end the band, which may be in lengths of 2,000 m. (6,500 feet), is split by slicing shears into the desired working widths and wound on bobbins.

The possibilities of the further application of this semi-finished product are almost unlimited. If wooden barrels are to be made, for instance, then a cylindrical tube is first wound. This is effected on a winding machine, which continually produces from the split laminated-veneer band a spiral-wound cross-laid and, therefore, extremely strong and homogeneous tube. The crossed spiral design is obtained by means of an overtake device on the machine. In addition, the machine described is equipped with an automatic parter which cuts the tube into sections corresponding to the desired height of the barrels. The barrel bodies so produced are then pressed on a heated hydraulic press and are finally fitted with hoops of the number and strength called for by the use for which the barrels are intended. This is effected on a hoop-winding machine on which the hoops are produced from the same laminated ribbon as the barrel bodies.

Parallel with the production of the bodies goes the manufacture of the lids and bottoms. These parts likewise are made from laminated veneer. The forming is done on a special press.

It has only been by the evolution of an economical process of manufacturing laminated veneer that it has become possible to produce many types of finished goods combining high strength with light weight and low price. The fields of use of the material are so numerous that it would be impossible to name them all. Mention shall, however, be made of a few.

The development of *spiral-wound barrel* bodies also provided the means for the manufacture of wooden tubes of high strength. By this process, pipes and tubing ranging in diameter from 25 to 1,000 mm. (1 inch to 3½ feet.) and a length of up to 15 m. (50 feet) can be produced. Completely corrosion-proof tubes, and tubes capable of withstanding pressure, can be made in this way. The strength of

such *pipes* and tubing may be assumed as being equal, for the same weight, to mild steel. Because of this high strength, the material may also be used in *airplane construction*, particularly since round as well as formed tubing can be produced.

Also for the production of packing containers, the laminated-wood ribbon is the ideal product. It is especially well suited as a substitute for tin plate because of its high strength and the fact that it can be shaped without machining. A further prominent characteristic of the material is the fact that its heat conductivity is 106 times as low as that of steel.

As has already been mentioned, laminated veneer can also be formed without machining. When properly employed and with the aid of suitable precautionary measures, the material may be spun like sheet metal, coined, and drawn. In this manner, a multiplicity of articles can be produced, such as airplane fuselage and automobile-body components, water troughs, sewage pipes, drainage pipes, and more.

The importance and value of the material will be evident from the fact that, with large outputs, production costs may be reduced to where the laminated-veneer band approaches the cost of cardboard. When it is further considered that the manufacture of cardboard calls for large mechanical equipment and involves the use of a great deal of heat, it will be realized that there are potent arguments in favour of a material produced directly from the green log at a minimum expenditure of power and heat.—(*Engineering Progress, Berlin, October* 1936.)

SANTONIN SUBSTITUTE EXPLOITED IN JAPAN

Alantolactone, one of the components of the complex crystalline derivative from elecampane (inula helenium), is being exploited in Japan as an anthelmintic, with the claim that it is "four times as strong" as santonin, according to information received by the Department of Commerce from the Assistant Trade Commissioner at Tokio.

In the study of native plants for anthelmintic properties, a Japanese scientist some three years ago discovered some promise in the root known as *ogoruma* which is said to be the inula, long popular as a cough medicine in many countries. Early experiments with the active principle derived from this root indicated that its use produced certain ill effects, probably caused by the helenin that is associated with the alantolactone and has been suggested as a powerful germicide in intestinal and respiratory inflammations. Purification (separation, probably) is said to have afforded the lactone ($C_{15}H_{20}O_2$) in a form that did not have the untoward properties, but was proved by clinical tests to possess strong anthelmintic qualities.—(*Oil, Paint and Drug Reporter*, January 4th, 1937, p. 50.)

[In this connection we publish below an extract from the Progress of Forest Research in India, 1931-32, by Dr. Krishna, the Biochemist of the F.R.I.—HON. ED.]

Extract from the Progress of Forest Research in India, 1931-32, *Part I*, *page* 76.

(c) ESSENTIAL OIL.

Inula spp.—In India some 20 species of *Inula* occur and many of them are extremely abundant plants, for example, *I. cappa* DC., a shrub met with on temperate Himalayas from Kumaon to Bhutan at 4,000—6,000 ft. *Inula racemosa* and *I. roylei* are found in Kashmir and have, hitherto, been used mainly for adulteration of *kut* (*Saussurea lappa*). Of these *I. racemosa* is better known because of its stronger aromatic odour. The dried roots have a weak odour, resembling orris and camphor. *I. racemosa* and *I. roylei* are not included in the British Pharmacopœia. Extra Pharmacopœia, however, mentions inula or elecampane, the rhizomes and roots of *I. helenium* (Fam. Composita), a large perennial herb indigenous to Central Europe and Asia. The rhizomes and branching roots when extracted give 35—45 per cent. of inulin and 1—2 per cent. of alantol, a crystalline or somewhat oily substance consisting chiefly of alantolactone which is commercially known as "helenin" or "alantcamphor" or "oil of elecampane."

Examination of *I. racemosa* and *I. roylei* have given the following results :

Species.	*Alantolactone.*	*Alantol.*	*Inulin.*
	Per cent.	Per cent.	Per cent.
I. racemosa ..	7.0	1.0	10.0
I. roylei ..	1.5	1.5	10.10
I. helenium ..	1.5	1.5	35—45

These results indicate that *I. racemosa* is superior to *I. helenium* of commerce in its essential oil content.

THE ORGANISATION OF THE INTERNATIONAL TIMBER MARKET

The Convention made on 15th November 1935 at Copenhagen between the representatives of the timber exporting industries of the principal European countries concerned, and ratified by the contracting countries and accordingly coming into force from 1st December 1935, constitutes a very important event in the history of timber economy. It is in fact the first time that the contracting countries have formally undertaken to observe the fixed quantities of timber exports as limits of the offers to be admitted for each country respectively over a given period.*

In order to gain a correct idea of the importance of this agreement, of which more will be said later, it may be useful to survey rapidly the international activity of recent years the object of which was to remedy the serious crisis which has affected the timber market since the end of 1929.

* L'Economie internationale. *Revue de la Chamber de Commerce internationale*, Janvier 1930—Internationaler Holzmarkt, Vienne, 14 December 1935.

A brief mention will suffice for the international congresses which from 1900 up to 1931 dealt expressly with the timber problem, the principal being the International Congress of Silviculture at Paris of 4th to 7th June 1900, the International Forestry Congress at Paris from 16th to 20th June 1913, the International Timber Conference at Bratislava from 31st August to 1st September 1923, the International Timber Congress at Lyons from 29th to 31st October 1924, the International Congress of Silviculture in Rome from 29th April to 5th May 1926, the Second International Timber Congress at Bratislava on 30th to 31st August 1929, and the International Congress of Timber and Silviculture in Paris from 1st to 5th July 1931. *

These meetings undoubtedly contributed in varying degrees either directly or indirectly to bringing the problem of the international regulation of the timber market nearer its solution, more particularly by outlining the idea of an international collaboration and by preparing the ground for schemes of collective action. None the less, from the point of view with which we are here concerned, they did not attain to the practical importance of the later meetings with which it is here proposed to deal, and which form, so to speak, an organic and progressive whole.

To examine first the situation in the timber trade as it was at the time when the first definite steps in the direction of international organisation of this market were taken, and further to investigate the most evident causes of the crisis in respect of timber as they emerge from the report of the Delegation of the Economic Committee of the League of Nations relating to the meeting of timber experts held at Geneva from 25th to 27th April 1932.

The serious overproduction crisis which for some years past had affected the world economy had also made itself felt in relation to silviculture.

The demand for timber has continued to increase in the last decades along with the growth of population. Other factors had

* Crespol, Paris. Le marche du bois et son organisation internationale. Paris, 1933, pp. 71, 154.—Hanns Mayr. Das Problem der Schnittholzpreisbildung. Munchen and Leipzing 1932, p. 120.

stimulated this demand in the course of more recent years to an even higher pitch ; among such contributing factors may be mentioned the reconstruction work in the devastated regions, the necessity for repairing or renewing buildings, plants, railways, mines and all else which had been bound to be neglected during the war, also the new requirements of comfort, and the greatly increased consumption of paper, cellulose and artificial silk.

Starting from 1930 there was on the contrary evident a marked restriction of the consumption of timber. England which has always been the principal importing market and has consequently regulated prices, reduced imports of sawn timber from 9,137,000 cubic metres in 1929 to 8,633,000 in 1930 and to 7,608,000 in 1931. In Germany the imports of resinous timber fell from 7,930,000 tons in 1928 to 5,008,000 tons in 1930 and to 2,845,000 in 1931. In Italy the imports of sawn, round and squared timbers which in 1927 amounted to 1,684,000 tons, fell to 1,542,000 in 1930 and to 1,141,000 in 1931. This fall has been attributed mainly to the economic crisis, as the timber market is intimately connected with the general prosperity. The crisis does not merely affect the activity of the building industries (partitions, planks, doors and windows, etc.) and of the furniture industry, with the quantity of packing material in demand, but also the activity of ship building, railway and mine construction, etc.

Other factors have contributed to this process. Among these are the remarkable reduction in the dimensions of modern buildings and apartments, as well as the marked progress made at the expense of building timber by other materials, such as cement, iron and steel, plaster, bricks, etc. Wood is increasingly replaced by iron and reinforced concrete as material for the construction of buildings, bridges, etc. The use of metal furniture is on the increase. Less timber is used in mines; a thinner type is in use and some shafts are concreted. The various applications of plywood make it possible to utilise wood at a much reduced volume : for purposes of resistance a ply 3 mm. in thickness replaces a plank 12 mm. thick.

On the other hand Russia which before the war had been the principal supplier of timber in Europe but which since then had ceased to export, had reappeared on the market; from 1927 its export increased rapidly; in 1931 Russia supplied 20 per cent. of the world export with 955,000 timber standards.

In several other countries the stoppage of the Russian exports had stimulated the production of sawn timber, and these, in consequence of the reduced consumption and of the renewed Russian exportation, found themselves faced by serious difficulties in marketing their excess production abroad. Finland which had exported 1,278,000 standards in 1927, exported 900,000 in 1930 and 780,000 in 1931. Sweden which had exported 1,181,000 standards in 1929, exported 996,000 in 1930 and 729,000 in 1931. The same had occurred for the other exporting countries.

The situation was rendered still more serious by the continued fall of prices which had not been checked by the diminution of exports. Prices taken as a whole represent only half and less even of what they were before the crisis; in many cases they have become less than the costs of transport, transformation and consignment of the rough timber from the forest.

Not only has the consumption capacity of timber diminished still more than the quantity available but the export possibilities have been reduced of late in consequence of the restrictive measures adopted by various countries, with the object of protecting their national production against the depreciation of prices. Exporters have lowered their prices further, whether in order to surmount the barriers of increased customs duties, or so that they may keep abreast of a keen competition within the narrow limits of the quotas imposed by the importing countries. The quantities unsold in consequence of the exhaustion of insufficient quotas, have exercised an increased pressure both on the market of the exporting country and also on the markets on which this country has attempted to sell its surplus timber.*

* Economic Committee of the League of Nations. The timber problem. Geneva, 1932, p. 6.

The International Conference of Timber Exporters held at Warsaw on 25-26th June 1931 was of opinion that the principal cause of the timber crisis, as that of the crises affecting other economic spheres, lay in the disparity between supply and demand on the world markets, and that the efforts made singly up to the present by the exporting countries with the object of relieving the crisis had had no appreciable result on account of the want of co-ordination in the means employed; the crisis could only be met by an international policy agreed between exporting countries, a policy which should lead to a stabilisation of the market without injuring the interests of importing countries, of importers and consumers of timber, and in such a way as to be compatible with the appropriate economic conditions of the exporting countries.

The members of the Conference added that they considered that the contracting countries would be able to contribute to a remedying of the situation if they would agree to fix for a period of several years their quotas of the total of exports (exports destined for the Far East not to be taken into consideration). In addition the agreement should, in the opinion of the members of the Conference, include all soft woods; sawn, planed, and cut for the purpose of making cases, as well soft timber in the round, sold abroad for shaping, etc. During the period of the agreement in question, the representatives of the contracting countries would be obliged to determine each year before 1st July and in accordance with the market situation in the importing countries, the total of the exports which were to serve as basis for the calculation of exportable quantities for each country during the following year. After having submitted a recommendation in respect of statistics and having expressed the desire that the countries not represented at the Conference should be invited to associate themselves with this policy, the Conference expressed the opinion that such a programme could be executed only if in each of the countries taking part in the agreement an appropriate export organisation supervised the carrying out of the joint export policy. Naturally each country should be free to choose the form to be given to its own

organisation and to regulate the relations existing between such organisation and the exporters.*

The experts meeting at Geneva in April 1932 and belonging to Germany, Austria, Canada, Finland, France, Great Britain, Italy, Latvia, the Netherlands, Poland, Rumania, Sweden, Czechoslovakia, the U. S. S. R., Yugoslavia, with the collaboration of the International Institute of Agriculture represented by several of its officers, examined the means which could be employed on the international plane for remedying the situation.

The report, after noting the impossibility of increasing the demand, also recognised the impracticability of effecting an agreed limitation of fellings in the existing state of affairs. It was very difficult to intervene in the forest policy of any country and the States with large timber resources refused to consider the question, in view of the development of their national economy and of their home consumption. Besides there would be no way of enforcing international control over the limitation of fellings. Such a measure however, if realisable, would not only tend to remedy the crisis but also to reduce the shrinkage of forest reserves which has caused anxiety for some time past to economists. The crisis which has affected the timber industry has in fact a somewhat paradoxical character. On the one hand there is an overproduction in quantity which oppresses the market; on the other hand there is a world consumption of timber which, reduced though it is by the general economic depression, remains, as is generally admitted, in advance of the possibilities of the natural increase of the forests which can be economically worked. In this way a continual diminution in the forested areas is going on and the average production capacity is also becoming lower in the forests which still exist. The classic works on silviculture state that out of 1,500,000,000 cubic metres representing the world consumption, 1,000,000,000 only comes from normal fellings, and that one-third of the consumption, 500,000,000 cubic metres, is obtained by drawing on the forest capital. It has been said that

* Glesinger E. Le Bois en Europe. Etudes d'economie internationale. Paris, 1932, p. 239.

in present conditions the timber crisis would find a solution if there were means of bringing about throughout the world the triumph of the principles of a scientific forest economy and if a stop could be put to the irrational exploitation of the "timber capital." The recommendation was made in the Committee of Experts that the International Institute of Agriculture should give the fullest consideration to this question and should take steps to group all the documentation necessary to the clear perception of the possibilities of an international convention, the object of which would be to ensure the respecting of the principles of a scientific forestry exploitation in all the European and extra-European producing countries.

However, as already stated, in the present state of affairs, an agreed limitation of fellings would be impracticable in application. The experts of the exporting countries represented at the meeting were unanimous in the opinion that in default of a restriction of forest workings, a regulation of exports might contribute to the relief of the market.

In fact if in normal times, according to the opinion of certain experts, the principle of free trade alone can ensure the prosperous development of the international timber trade, on the other hand in a period of crisis, the unlimited freedom of timber exports has as consequence the aggravation of the existing want of equilibrium, the lowering of prices, tendency for stocks to lose value, the disorganisation of timber production and of the trade in timber. Efforts have been made to counteract this price lowering. Certain countries have *recognised the dangers that threaten the timber market*, and have reduced their production at the base by a limitation of fellings, others have tried to regulate demand by agreements made between exporters. On the national sphere, powerful and well disciplined organisations have been formed and have carried out a reduction of exports in their respective countries. All these efforts, however, display a lack of co-ordination which, *inter alia*, has so operated that while certain countries reduced their production or subjected it to a quota policy, others increased their production.

In the course of the meeting, the experts of the exporting countries stated that their countries possessed or could easily establish central organisations which could in their name take part in an international arrangement of a commercial character, and they came to an agreement on a series of points :—

(a) They were of opinion that the only means of immediate assistance lay in the adaptation of the exports of all the exporting countries to the absorption capacity of the importing countries, equitably established on the basis of a cordial understanding. This adaptation should be defined by means of a percentage and should besides correspond to the actual import needs of the consuming countries.

(b) For estimating the consumption requirements, the basis taken should not be theoretical figures, but rather the statistics of recent years; in view of the existing situation, the estimates should also be reduced by a "crisis percentage" to be determined.

(c) In order to fix the percentages to be reserved on the exports of the different countries, the special conditions of the producing countries and of the national timber industries should be taken into consideration.

(d) In order to fix the quotas of distribution and the quantity to be introduced into the importing countries, purely commercial negotiations should be initiated between the exporting countries concerned. The collaboration of the importing countries concerned is essential to the satisfactory conclusion of these negotiations.

The experts of the exporting countries of Northern Europe expressed their willingness to initiate immediately between themselves negotiations of a commercial character for the regulation of questions relating to timber pending among them. The experts of U. S. S. R. have undertaken to recommend to the Soviet export organisations to take all possible steps in view of the conclusions of commercial agreements with the export organisations of other countries.

The experts of the Central European countries considered that the ideal would be a general agreement for which the agreement between the Northern States would form a preparation of much

importance. If, however, there would be found to be insurmountable difficulties in the way of such a general agreement, the States of Central Europe were of opinion that it would be of advantage to arrive at an understanding among themselves. In any case they resolved to organise, on 9th June 1932, at Vienna, a meeting to which there should be invited all the countries concerned, represented or not at the meeting of experts just reviewed.*

We thus come to the International Timber Conference held at Vienna. At this Conference there took part Germany, Australia, Belgium, Spain, the United States, Finland, France, Greece, Hungary, Italy, Latvia, the Netherlands, Poland, Rumania, Sweden, Switzerland, Czechoslovakia, the U. S. S. R., Yugoslavia who all sent experts; Sweden, Italy, Greece and Hungary sent observers only, and Great Britain was not represented. The main object of the Conference was to ascertain which countries were prepared to submit voluntarily to a reduction in production and export of timber, so as to establish an equilibrium between supply and demand and to render possible remunerative prices.

In the course of the discussions there were evident marked differences of attitude. At the same time from the beginning, six countries, Austria, Latvia, Poland, Rumania, Czechoslovakia and Yugoslavia showed themselves favourable to an arrangement which was supported by France.

The positive outcome of this meeting was an understanding between the countries enumerated above, with a view to undertaking a joint action with the object of remedying the international timber market and of ensuring a limitation of exports so as to re-establish the equilibrium between supply and demand. They decided upon the formation of a permanent committee designed to secure the continuity of the work carried on. The agreement was to remain open for the signature of the national organisations of other countries who might desire subsequently to adhere to it.†

*Economic Committee of the League of Nations, document quoted, p. 9.

†L'economie internationale, already quoted, October 1934, p. 5. Economic Committee of the League of Nations. Document E 854 of 30th June 1934.

The Permanent Committee, formed by the so-called States of Central Europe with headquarters at Vienna, assumed the name of the International Permanent Committee of the production of timber, the timber industry and trade in timber (C. I. B.). This body constitutes also for the northern countries a first step in the direction of the international organisation of the timber market. Sweden, Finland, the Baltic States and the U. S. S. R. have, however, as yet not joined. France became a participator in the C. I. B. from 1933. The activity of this organisation is mainly exercised in three spheres: (*a*) technical operations, (*b*) regulation of the market, (*c*) inter-European timber policy.*

The action taken by these countries soon bore fruit. In December 1933 an International Conference of timber exporters was held at Berlin, and under the presidency of Count Ostrowski, President of the C. I. B., resulted in an agreement in respect of timber exports.

As the outcome of the exchange of views among experts, this Conference had been instructed to draft on the basis of statistical data, a common policy for the export of timber during the following season.

The negotiations were carried on between, on the one hand, well-known leaders in the timber trade of Sweden, Finland, and the U. S. S. R., and on the other the principal delegates of the exporters' organisations, members of the C. I. B.

In the first place an agreement was reached as to the estimate of the world demand of the importing countries for 1934; this demand was estimated at 4,200,000 standards. Then the representatives of all the countries present declared that they would endeavour to secure that the exports of sawn timber of their country should not exceed in 1934 a fixed number of standards. The total of these quantities to be exported was in complete agreement with the total figure estimated for the importations.

This "gentlemen's agreement" between European timber producers, members of the C. I. B., from which, however, Sweden and

* L'economie internationale, already quoted. October 1934, p. 5. Economic Committee of the League of Nations. Document E854 of 30th June 1934.

France abstained, resulted in a certain stability of the price of timber on the world markets.*

At the end of October 1934 a second conference of timber exporters took place at Vienna, under the presidency of Count Ostrowski. This meeting was the direct continuation of that held in Berlin in 1933 but the basis of operation had been considerably widened, as the number of European States represented at Vienna was augmented by the participation of the Baltic States. There was thus represented 99 per cent. of the total production of the European exporting countries. It should be added that a representative of Canada took part in the Vienna meetings; this country since the Ottawa Conference has become one of the most important suppliers of timber to Europe. † Hence with the exception of the United States, Norway and Lithuania, representatives of the timber export of the world were present together at Vienna.

The Conference proceeded to the estimation of the imports and exports relating to 1934 and to the great satisfaction of its members it was confirmed that not only had the estimates of the volume of the world imports in soft wood made at the Berlin Conference proved to be exact, but that the "gentlemen's agreement" had secured excellent results, for as its outcome the world prices of timber had shown—in contrast to the preceding years—a remarkable stability with a slight tendency to rise.

The Vienna Conference was continued on these lines. After an exchange of views on the probable extent of the demands of the different markets in 1935, those taking part in the Conference, after making an enquiry into the importing markets, pronounced in favour of the establishment of a new approximate figure lower by 10 per cent. than the total of the imports for 1934. In consequence the Conference recommended all the timber exporters to reduce their future timber export in the same proportion. This resolution does not imply any compulsion. But just as the Berlin agreement, in spite of its purely optional character, has been strictly observed by the adherents, it was possible to cherish a legitimate hope that the same destiny would be that of this Conference.

---

* L'economic internationale already quoted. October 1934, Economic Committee of the League of Nations document E-871 of 18th January 1935.

† *Internationale Holzmarkt* of 27th October 1934.

It should be noted that the Baltic, Russian and Swedish delegations emphasising the solidarity of the interests of all timber exporters, have promised their loyal collaboration to the execution of this arrangement. The Canadian observer announced the approaching establishment in his own country of a central organisation for timber export, and also promised that in the near future his country would participate in these agreements.* In addition this Conference, after having passed resolutions in regard to the standardisation of squared timbers, to the organisation in February at Warsaw of an international conference on the subject of wood used for paper manufacture, and finally on timber statistics, was unanimous in declaring that meetings of the same kind as those of Berlin and Vienna should be held at least once a year. On the proposal of the Swedish delegation, the President of the Conference has been authorised to place himself in touch at any time with the delegations of the other exporting countries and to invite them to discuss any question which it might be necessary to consider.

In virtue of this advisory arrangement it is open to all competent organisations to come in and adopt a line of joint action whenever required by the situation.†

We now come to the Convention signed at Copenhagen on 15th November 1935 by the representatives of the timber exporters of the principal European countries concerned, which constitutes a remarkable advance on the agreements concluded at Berlin and Vienna.

By this agreement, the contracting countries for the first time enter into a formal undertaking to regulate the European trade in sawn timber and to establish in this way the bases for a steady development of the market. Such was the fortunate outcome of the intensive and persistent labours that had been carried on.

The Baltic States, Norway, the United States and Canada do not belong to the Convention but estimates have been reached of the exports of these countries and are taken fully into account in the agreement.

The total exportation for the countries participating in the Convention has been fixed for 1936 at a maximum of 3,850,000 standards

* L'economie internationale of January 1935.

† Economic Committee of the League of Nations, doc. E 871 of 1st January 1935, p. 5.

which cannot be exceeded. The distribution of this **maximum** established between the different countries is as follows:

			Standards.
Austria	..	..	275,000
Finland	..	..	1,005,000
Poland	..	..	313,000
Rumania	..	..	223,000
Sweden	..	..	820,000
Czechoslovakia	..	..	96,000
U. S. S. R.	..	..	950,000
Yugoslavia	..	..	168.000
	Total	..	3 850.000

This Convention was ratified by the contracting States and therefore came into force as from 1st December 1935.

At the beginning of December, Rumania had not as yet ratified the Convention but it was expected that this would be done at any moment.

According to statistics published by the C. I. B. for 1934, the proportion of sawn timber exported by the contracting countries comes out at 4 per cent. for Austria, 19 per cent. for Finland, 6 per cent. for Poland, 5 per cent. for Rumania, 16 per cent. for Sweden, 2 per cent. for Czechoslovakia, 18 per cent. for the U. S. S. R., 3 per cent. for Yugoslavia. The proportion of exported sawn timbers from European countries not taking part in the Convention reached 1 per cent. for Estonia, 3 per cent. for Latvia, 1 per cent. for Lithuania and 1 per cent. for Norway. Overseas countries exported to Europe as follows : Canada 11·5 per cent. and the United States 9·5 per cent. of the total amount of their respective sales.

The Permanent Executive Committee has been established, representing the associations which subscribe to the Convention. The Committee consists of six delegates, three appointed by Finland, Sweden and the U. S. S. R., and the remaining three jointly appointed by Austria, Poland, Rumania, Czechoslovakia, and Yugoslavia. In addition a technical Committee was instituted to undertake the supervision of the operation of the agreement; on this Committee each country has the power of representation by a single delegate.—(*Monthly Bulletin of Agricultural Economics and Sociology, No. 2,1936.*)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for March 1937:

IMPORTS

ARTICLES	MONTH OF MARCH					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER Teakwood— Siam ..	..	..	30	..	..	4,659
French Indo-China ..	1,649	122	449	1,18,676	15,717	47,270
Other countries ..	..	..	203	..	..	22,574
Total ..	1,649	122	682	1,18,676	15,717	74,503
Other than teak— Softwoods ..	1,195	883	1,528	73,638	55,858	1,00,234
Matchwoods ..	..	..	807	.	..	45,111
Unspecified (Value) ..	..	..	..	2,48,878	1,06,933	16,201
Firewood ..	18	66	40	270	990	600
Sandalwood ..	25	9	57	13,429	1,450	12,503
Total value of wood and timber ..	..	..	..	4,54,891	1,80,948	2,49,152
Manufactures of wood and timber— Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	362	..	..	81,557
Other manufactures of wood (Value) ..	..	..	..	2,05,348	1,91,661	1,66,738
Total value of manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	2,05,348	1,91,661	2,48,295
Other products of wood and timber— Wood pulp (Cwt.) ..	35,956	15,143	19,292	2,38,360	98,336	1,33,818

IMPORTS

ARTICLES	TWELVE MONTHS, 1st APRIL TO 31st MARCH					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934-35	1935-36	1936-37	1934-35	1935-36	1936-37
WOOD AND TIMBER						
Teakwood—						
Siam ..	3,794	277	974	4,14,751	26,616	1,20,371
French Indo-China ..	4,748	547	3,149	3,78,282	65,196	3,25,543
Other countries ..	..	158	1,884	89	15,811	2,04,935
Total ..	8,542	982	6,007	7,93,122	1,07,623	6,50,849
Other than teak—						
Softwoods ..	11,131	12,815	14,493	7,20,333	7,54,430	8,75,039
Matchwoods ..	..	..	11,442	..	..	6,40,831
Unspecified (Value) ..	..	..	..	17,55,148	18,37,785	3,38,057
Firewood ..	586	506	365	12,787	7,497	5,463
Sandalwood ..	292	213	309	1,01,847	74,664	97,447
Total value of wood and timber ..	..	..	..	33,83,237	27,81,999	26,07,686
Manufactures of wood and timber—						
Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	..	3,469	..	..	7,70,423
Other manufactures of wood (Value) ..	..	..	..	22,95,873	25,60,442	15,23,444
Total value of manufactures of wood and timber other than furniture and cabinet-ware	..	..	..	22,95,873	25,60,442	22,93,867
Other products of wood and timber—						
Wood pulp (Cwt.) ..	390,123	309,422	220,944	26,18,243	20,47,566	14,56,125

EXPORTS

ARTICLES	MONTH OF MARCH					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	6,593	5,223	5,028	12,40,523	10,29,232	11,13,792
,, Germany ..	546	219	1,162	1,31,848	42,122	3,17,880
,, Belgium ..	20	5	73	4,701	912	14,531
,, Iraq ..	97	127	64	16,826	19,827	11,261
,, Ceylon ..	168	284	254	30,728	32,458	41,942
,, Union of South Africa	917	807	282	1,93,691	1,70,396	63,630
,, Portuguese East Africa ..	429	238	174	75,218	35,178	33,125
,, United States of America ..	477	53	38	1,20,666	15,901	9,515
,, Other countries ..	427	817	595	70,487	1,02,977	1,25,765
Total ..	9,674	7,773	7,670	18,84,688	14,49,003	17,31,441
Teak keys (tons) ..	976	634	536	1,46,400	91,800	92,985
Hardwoods other than teak ..	112	260	363	11,345	26,655	36,341
Unspecified (Value) ..	..	..	..	52,053	92,138	3,84,203
Firewood (tons) ..	..	2	..	8	20	..
Total ..	..	..	..	2,09,806	2,10,613	5,13,529
Sandalwood—						
To United Kingdom ..	..	..	11	..	..	11,600
,, China (excluding Hong-Kong) ..	10	..	6	15,507	..	6,600
,, Japan ..	7	..	5	8,925	..	2,766
,, Anglo-Egyptian Sudan ..	5	1	3	5,310	1,350	3,740
,, United States of America ..	24	50	84	24,069	50,000	87,400
,, Other countries ..	3	3	5	3,052	3,167	6,735
Total ..	49	54	114	56,863	54,517	1,18,841
Total value of wood and timber ..	..	..	..	21,51,357	17,14,133	23,63,811
Manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	12,896	17,538	28,886
Other products of wood and timber ..	No data.			No data.		

EXPORTS

ARTICLES	TWELVE MONTHS, 1ST APRIL TO 31ST MARCH					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1934 35	1935-36	1936-37	1934-35	1935-36	1936-37
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	29,352	39,385	45.789	61,86,003	76.41,719	95,88,315
„ Germany ..	2 321	4,587	5 695	5,65,457	10.40 232	14,00,574
„ Belgium ..	299	810	375	60,356	1,53,564	67 612
„ Iraq ..	957	1,019	769	1,95.571	1,78,564	1,34.967
„ Ceylon ..	949	1,524	1,682	1,35,952	1,94,702	2,44,258
„ Union of South Africa ..	3,630	3,695	6,383	7,87,293	6,61,997	13,13,894
„ Portuguese East Africa ..	737	2,028	2,141	1,29,006	3,26,793	3,71,275
„ United States of America ..	1,051	469	470	2,79,879	1,16,321	1,35 527
„ Other countries ..	3,801	4,725	6 178	7 01 707	8,58 589	13 38,652
Total ..	43,107	58,242	69,482	90,41,223	1,11,72,481	1,45,95,054
Teak keys (tons) ..	4,137	4,893	4,080	6,13,150	7,23,499	5,92,862
Hardwoods other than teak ..	738	1,064	1,860	74,039	1,13,859	1,89,272
Unspecified (Value) ..	..	..	..	3,72,810	4,07,728	12,14,900
Firewood (tons) ..	132	68	7	2 411	907	111
Total ..	..	..	..	10 62,410	12 45,993	19,97,145
Sandalwood—						
To United Kingdom ..	32	37	19	39,586	42,276	19,903
„ China (excluding Hong-Kong) ..	61	30	77	94,772	42,690	94,177
„ Japan ..	96	112	85	1,01,794	1,21,777	1,41,524
„ Anglo-Egyptian Sudan ..	53	66	73	56,685	85,065	80,495
„ United States of America ..	412	569	539	4,72,869	5,78.090	5,81.948
„ Other countries ..	21	48	52	36,030	55.443	68,914
Total ..	675	862	845	8,01,736	9,25,341	9,86,958
Total value of wood and timber ..	..	..	..	1,09,05,369	1,33,43 815	1,75,79,157
Manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	1,21,901	1,13,003	1,67,662
Other products of wood and timber ..	No data.			No data.		

INDIAN FORESTER

JULY, 1937.

A CAREER IN THE FOREST DEPARTMENT

Sir Gerald Trevor, Inspector-General of Forests, in the course of his broadcast talk on " A Career in the Forest Department " from the All-India Radio, Delhi, said :

" I have been asked to speak to you to-night on a career in the Forest Department and before I can get on to details of the work I must first of all give you an outline of what the forests of India are like.

Forestry in India is different to that of any other country in that we have to deal with every kind of climate and every type of vegetation, from the alpine forests of the Himalayas to the tropical evergreen forests of the West Coast, from the desert forests of Sind and the Punjab to the bamboo-clad hills which form the eastern-most frontier between India and Burma. Starting from the North we have in the ranges of the Himalayas, from the North-West Frontier Province to Kumaon, coniferous forests of chir pine which is the source of a flourishing turpentine industry in India. These pines are tapped with one or more blazes or channels which are freshened five times a month, the resin runs down the blaze and drops over a tin lip into an earthenware cup. This is crude resin which then goes to the factory at Bareilly or Jallo near Lahore, where it is distilled into turpentine and rosin. The latter substance is largely used in Indian industry and the whole requirements of the country are met from this source. At elevations above the long-leaf pine, the well-known deodar forests are found from the North West Frontier Province through Kashmir and the Punjab to the sources of the Ganges. Above the deodar again extensive forests of spruce and silver fir grow up to an elevation of 10,000 feet, where they merge into the alpine pastures which provide summer grazing for thousands of sheep and goats.

In the plains of the Punjab, where the rainfall is insufficient to grow forests 50,000 acres of irrigated plantations of shisham and mulberry have been formed to supply the towns of the Punjab with firewood and you may be interested to know that all your hockey sticks are made from the latter wood. This sports-goods trade in hockey sticks and tennis rackets is centred in Sialkot and is of considerable value. The products of these factories go all over India and are even exported abroad. Suited mulberry wood for this trade commands a high price and the supply hardly meets the demand. Moving to the east of the Jumna river, along the foothills of the United Provinces, a belt of sal forests extends right along the Himalayas through Bengal into Assam. This tree is one of the most important in India providing large quantities of railway sleepers and the bulk of the constructional timber used throughout the Gangetic plain. Incidentally you may be interested to know that this is the tree described by the Chinese pilgrim Hiuen Tsang as the tree with dark green shining leaves under which the Lord Buddha died. We have had considerable difficulties with this tree and the problem of its regeneration is still the subject of intensive research. In consequence of this Bengal has had to undertake very extensive plantations of this tree.

At the end of the sal belt in Assam the tangle of broken hills which forms the boundary between Assam and Tibet is covered with evergreen forest and through a gigantic gorge in these hills the Brahmaputra river falls from the plateau of Tibet to the plains of India. One of the most interesting forest areas is the Sunderbans, in the Bay of Bengal, where the innumerable streams and tidal creeks of the delta of the Ganges meet the sea. The whole forest here is submerged at every spring-tide and everybody lives in boats. The trees also are peculiar as, in order to obtain oxygen in these mud flats, they send up aerial roots like tent pegs which cover the forest floor and render working rather an acrobatic feat.

All through Central India the teak tree is found in profusion generally mixed with other trees, sometimes reaching considerable size, and elsewhere, where the rainfall is deficient, only growing to the size of small trees. This mixed type of teak forest extends into the

Bombay Presidency in Kanara and continues right to South India in Madras, Cochin and Travancore. In this type of forest very considerable plantations of teak have been made, starting from quite early times. The most notable of these are the plantations in *Nilambur in Malabar which were commenced by Connolly, the Collector,* in 1842. The Forest Department has lately erected a memorial to *his memory. In* addition to the sal forests of the sub-Himalayas a very large area of this forest also covers the hills in Orissa and Chota Nagpur. This is still perhaps one of the wildest parts of India where at any time wild elephants, bison, and perhaps man-eating tigers, may be met with. I must not forget to mention the extensive areas of bamboos belonging to several species which are such a feature of Indian forestry. Bamboos are either the most profitable forest crop which can be grown or alternately they are so abundant as to be almost a weed of no value. However, thanks to the work done at the Forest Research Institute at Dehra Dun, these unwanted bamboos are now being used for the manufacture of writing and printing paper and the Indian paper mills now supply 75 per cent. of Indian requirements in these papers. There has lately been considerable activity in the promotion of new mills.

Having given you a very brief outline of the history of the forest vegetation of India, I will now come to the subject of a career in the Forest Department. The Forest Service in one of the major forest *provinces consists* of the Chief Conservator at the head with three or four Conservators of Forest under him. Each territorial Conservator has about six forest divisions, each in charge of a divisional forest officer, in his care. Each division has several ranges, each in charge of a Forest Ranger trained at Dehra Dun or Coimbatore, and each range in turn has a subordinate staff of forest guards. The working plans branch, which is responsible for laying down the technical forestry of each division and calculating the yield of the forests, works directly under the Chief Conservator. This, in brief, will give you an idea of how the work is carried out. Recruitment is made either direct *to the officer class or to the Forest Ranger class, but forest rangers* have an opportunity of rising to gazetted rank. The question is often

asked: What does a forest officer do? The answer is that the forest officer administers a large estate devoted to the production of timber as a crop. Forestry is only a branch of the cultivation of the soil. Agricultural crops occupy the ground for a year or a little more or less, and are then reaped and converted into cash. A forest crop may occupy the ground for 150 years before it is reaped. Another difference is that agricultural crops are sown or planted, whereas in forestry a new crop is most frequently obtained by natural seeding under the control of the forester. In addition to the cultivation and tending of forest crops the forest officer in charge of a division has the care of the estate in the shape of roads, buildings, boundaries, fire protection and has also the business side in the way of marking of trees and sales to attend to. Indeed he resembles in many particulars the manager of a big zemindari. Forestry is a business just the same as agriculture is a business. Frequently in the case of forests on the mountains the indirect results are of more importance than the cash returns. More and more in India the problem of erosion is being recognised and forestry is one of the chief means of dealing with this problem. A career in the Forest Service is not to be entered into lightly as it differs from the normal career to be expected in every other department of Government service. Most of your life will be lived in the remote places of earth, you will see little of towns or the amenities which are offered by the towns. For the first 15 years of my service I had no headquarters other than an Indian village. On the other hand you will be living surrounded by nature, very often your only companions will be the wild elephant and it is essential that those who seek to spend their lives in this service should be able to find their own amusements and their own resources in their own immediate surroundings. Those who enter the Forest Service should be somewhat like a pilgrim who undertakes the great journey to Kailash. He encounters many dangers and experiences great discomforts. Sometimes he is hungry, other times thirsty, the valleys are hot and the hills are covered with snow, but ultimately as he gets to the end of his journey and sees the holy mountain, the goal of his hopes for many years, he forgets all the discomforts of the journey

in the exultation of having at last obtained his desire. Similarly those who devote their lives to the service of the trees of the forest experience many physical discomforts and privations, the honours of this world only too often pass them by, they acquire but little of wealth, and ill health may be their portion, but having devoted their lives to the ordering and beautifying of the garden of the wilderness, having acquired wisdom and understanding of the ways of nature and obtained dominion over the world of trees, they may obtain something greater than earthly honours, namely, the knowledge that they have served their country well. *To those who are prepared to content* themselves with such rewards as the service offers, to those who are prepared to live alone and to find their interests in their work and in their surroundings, I would say by all means join the Forest Service; but to those who cannot live away from the amenities of towns and crowds of their fellow-men, I would say find any other employment rather than that in the forests.

You will now want to know how you enter on this career. There are two classes of posts in the service. The upper gazetted class and the lower non-gazetted Forest Ranger class. At the present moment recruitment to the gazetted class of the service has been closed down, but no doubt this is only a temporary measure. To get into the gazetted class a university degree is necessary followed by two years of professional training either at a forest school in Great Britain or at the Forest College in Dehra Dun. Before recruitment was closed down young men who were in possession of a university degree went up for a competitive examination followed by an interview with the Public Service Commission. Now that forests have been provincialised local Governments will no doubt select their own candidates for training. As regards the Forest Ranger class, candidates are required by certain local Governments to have passed at least the Matriculation examination and by others the Faculty of Arts or Science. Thereafter they are selected by their local Governments and deputed for two years of study at the Forest Colleges at Dehra Dun and Coimbatore. After completing the course both classes of officers undergo practical training in the forests of their province and

in due course the officer class will become divisional officers in charge of forest divisions. They will serve in this and similar capacities until they are selected for Conservator when vacancies occur. At the present moment officers of about 25 years seniority are becoming Conservators. The Ranger student, after leaving College, will be attached to a range where he will carry out the marking of trees for felling, road-making, repairs to buildings, the making and tending of plantations. He will probably be employed at some time on the field work connected with the preparation or revision of working plans. In due course he will be placed in charge of a range, a position of considerable importance, where he will have ample scope for the exercise of his profession as range officer. He will have a staff of subordinates under him and will be brought into intimate contact with large numbers of workmen and villagers. His powers for good will be great and he can spend a life of devoted service to his profession, his country and the poor people committed to his charge. I must not conclude this talk without a reference to the work of the Forest Research Institute at Dehra Dun. This Institute is concerned with research into the problems of silviculture or the growing of trees, forest utilisation or the uses of timber, the manufacture of paper pulp, the seasoning and preservation of timber and similar activities and the allied sciences of Botany, Entomology and Chemistry. It is one of the largest Forest Research Institutes in the world and an institution of which India may well be proud. Indeed forestry in India has reached a high standard and the forest services of India are looked up to by all parts of the British Commonwealth. Having seen the forestry of the whole world it is my hope that Indian forestry may long continue to occupy the prominent place she has attained, thanks to the devoted service of all classes of the staff, many of whom have laid down their lives in the execution of their duty. I wish you all good night."

REGENERATION OF PADAUK (*PTEROCARPUS DALBERGIOIDES*)—ARTIFICIAL AND NATURAL.

By M. S. Balasubramanyam,

Andamans Forest Department

Summary.—It discusses (1) whether the plantations have really cost so much per acre as to be *"deemed a financial failure from the start" and (2) whether the* results obtained in plantations are not as good as in natural regeneration.

"In deciding between natural and artificial regeneration, the economic aspect is the main deciding factor." In the following few notes I propose to examine the above statement with special reference to padauk, as it is easily the most valuable timber tree in the Andamans. "The timber is of first-class quality and commands the highest price of all the Andaman woods." (Annual Report, 1934-35, page 17.) The last decade of our intensive experiments with natural and artificial regeneration of padauk has given us sufficient data to discuss the technique and economics of both the methods.

Before entering into a detailed discussion on the above subject it would be better to start with a short *résumé* on the silviculture of padauk, as this will help us a lot in our further discussions.

Distribution.—In its natural habitat, *viz.* the Andamans, padauk occurs from sea level up to an elevation of about 250 to 300 feet, depending on the conditions of the soil. Soil is the determining factor, as the other ecological factors, such as climate and rainfall, etc., do not vary very much. It occurs in the types of forest recognised locally as the deciduous and the semi-evergreen. On rich, well-drained soils, varying from sandy loam to loam, such as those on Interview and Stewart Islands, the bole development is very good, while on a coarse-grained rubbly soil, as on Sound Island, padauk is comparatively stunted and buttressed.

Associates.—The usual associates of padauk are *Terminalias* (*T. bialata*, *T. procera* and *T. manii*), *Canarium euphyllum*, *Sterculia companulata*, *Lagerstroemia hypoleuca*, etc. These form the topmost canopy. In the second storey we find the various *Dyospyros* (including the Zebra wood of the Andamans), the *Sterculias*, and various other evergreen trees. The intensity of the undergrowth varies between light to fairly dense depending on the humidity of the soil.

Flowering and fruiting.—Padauk flowers profusely about the end of June and throughout July. The flowering season does not last long, and the green samaras soon appear. The fruits ripen about January-February and the ripe fruits can be seen on the tree till the end of May. The fruits (so-called seeds) are light (about 750 go to a pound) and are carried far by the high winds of the early monsoon.

Germination.—Germination is very uneven, beginning from the month of April and lasting till early October. If there is a good shower in March, a profusion of padauk seedlings is seen in April. Padauk is unique in this respect, and, as will be mentioned later, this has been the cause of the high cost or failure of many a plantation in the past. On account of this uneven germination, it appears, therefore, that the ripe padauk seed, which falls during a certain month, does not germinate at once, but lies in contact with the soil for some months at least (probably four to six) before it germinates. Padauk seeds are the first to germinate in an area and, probably, also the last.

Silvicultural characteristics.—Padauk is a strong light demander and is very sensitive to suppression by weeds. Forest officers of the Andamans have always noticed at the commencement of the monsoon profuse natural regeneration of padauk coming up in all the old felling areas, drag paths and other places, but none of these seedlings are seen after a month. Want of overhead light and suppression by weeds kill out all the seedlings. But if due to some favourable circumstance a padauk seedling gets established, the young plant persists and grows very slowly even under the most unfavourable circumstances existing in a natural forest. The response to treatment is, however, marked. Given a free leading shoot, free from suppression and fully exposed to light, very vigorous growth results. It loves to be in the midst of weeds of equal height, and, in fact, plants growing amidst a profusion of erect weeds of equal height are much more healthy than those that are constantly weeded. Climbers are very injurious to the seedling up to its third year, as they bend the plants right down and retard their growth.

STEWART ISLAND REGENERATION; 1934 AREA
HEIGHT GROWTH ABOUT 20 FEET

Subsequent growth.—Compared with the growth of the seedlings of its associates, the development of the padauk seedling in the first two years of its existence is very slow. So in natural regeneration areas padauk does very badly in competition with other quick-growing spp., such as white *dhup* (*Canarium euphyllum*), *papita* (*Sterclia companulata*), white *chuglam* (*Terminalia bialata*), *pynma* (*Lagerstroemia hypoleuca*), etc. From the third year onwards growth is more rapid, and it overstops *dhup* if left under it. Trees with heavy foliage like *pynma*, *chuglam*, *badam* (*Terminalia procera*) suppress it very badly and must be cut back to release padauk.

Natural reproduction.—It has been variously observed by forest officers in the Andamans, from time to time, that "natural regeneration (of padauk) in the areas worked over is generally good" and "regeneration of padauk although plentiful is quickly suppressed unless tended and completely freed from overhead cover," and so on. In fact, as has been already mentioned, padauk regeneration is profuse and is the first to appear on the area. In the natural regeneration technique that has been developed so far, we start with a clean forest floor and a canopy raised up to a height of about 80 feet. We may go a step further and say that all trees, except those forming the topmost canopy, are to be felled or killed by girdling. In the deciduous forests the slash is burnt, as far as possible before April, *i.e.*, before seedfall. The ideal condition to start with will be a clean forest floor, shaded by one unbroken topmost canopy, but in actual practice it happens that the top storey is interspersed with gaps due to past fellings.

With the rains there is plenty of padauk germination and along with it the germination of the other deciduous associates of padauk is also prolific. Anything up to 20,000 seedlings per acre can be seen. From now on there is a race between the padauk seedlings, the weeds and climbers, and the seedlings of white *chuglam*, *pynma*, *dhup*, *papita*, etc. Padauk suffers very badly in this competition. The other species having a more even germination, a rapid growth and more toleration for shade easily oust the padauk from the field. So if no assistance is given to the padauk at this unestablished stage,

casualties are heavy, and about 90 per cent. of the seedlings disappear after a month. It is necessary, therefore, at the time of weeding to cut back other species to save the padauk. This cutting back must be done very quick, as otherwise the casualties are heavy and the growth of the survivals poor.

By weeding whenever necessary, and by gradual girdling of the overwood, the young crop is kept alive. By the gradual removal of the overwood it is expected to strike a mean between the light requirements of the trees and the weed growth. The following points deserve mention at this stage. Felling, raising the canopy and weeding have been continued till the fourth year. In weeding it is necessary to go over the whole area to attend to each and every seedling. People acquainted with the conditions existing in a tropical rain forest can form a fair estimate of the difficulty of keeping a regeneration area free from weeds.

Costs vary considerably. At the end of the fourth year the cost is between Rs. 35 and Rs. 55 per acre, at the end of the third it is between Rs. 21 and Rs. 33, and at the end of the second it is Rs. 25 to Rs. 38 (this is in a special area with heavy weed growth, hence the cost here is even more than the cost at the end of the third year in other areas). "Costs vary considerably. The cost of felling depends on the intensity of the exploitation fellings which preceded the regeneration fellings. Burning depends on the nature of the undergrowth: Whether a considerable time has elapsed between the exploitation felling and the regeneration felling in which case the areas are usually choked with cane; cutting and burning this is expensive. The costs of weeding depend partly on the nature of the soil and partly on the denseness of the canopy." (Annual report, 1934-35.)

Artificial reproduction.—Plantations: I consider here the plantation practices only with regard to padauk, because, as has been stated above, it is the most valuable spp. in the Andamans and requires special attention during the initial stages of its establishment and growth.

Since the year 1934-35 no new plantation work has been undertaken, and, according to the Annual Report of 1934-35, "it was decided, owing to the initial cost, to discontinue all plantations." The report goes on to remark that "the results obtained do not compare *favourably with natural regeneration.*" Whatever might have been the results of padauk and other plantations in the South and Middle Andamans, the North Andamans experience has shown that of the plantations of all the species tried, those of padauk are, perhaps, the best. Every visiting officer has always been struck with the amount of success attained in the North Andaman plantations, and in the words of Mr. Foster (the present Chief Forest Officer, Andamans) "the plantations are well stocked" and are "a fine piece of work and the results are a very striking contrast to Bomlungta" (Middle Andamans).

Planting practices and costs.—The history of padauk plantations in the Andamans starts with 1883, and was continued till the year 1933 with varying degrees of success. In the North Andamans, however, the first plantation was started in the year 1926 and was continued till 1933-34 when it was stopped for reasons mentioned elsewhere. To go into a detailed account of the various methods adopted would take us very far beyond the purpose of this note, but a word or two about the North Andaman practices will suffice. The North Andaman plantations can be divided into two groups—those up to 1929-30 and those from 1930 to 1933. Experiments in sowing treated or untreated seeds directly in lines, experiments in planting or sowing distance, in sowing with field crops such as sugarcane and maize between the lines (a sort of *taungya*), etc., were all tried. Though these methods were quite successful, costs were prohibitive.

			Rs.	a.	p.
1926-27	.. cost per acre	..	268	0	0
1927-28	.. ,,	..	227	0	0
1928-29	.. ,,	..	323	0	0
1929-30	.. ,,	..	185	8	0

The above costs do not take into account the revenue credited to plantations due to sale or value of field crops raised between the lines.

The reasons for the high costs have been various, the most important being the uneven germination of the seed which necessitated constant weeding of the lines. There was also a tendency on the part of the supervising staff to pay more attention to the field crops than to the forest crop. As the total area, however, planted during the period was only about 60 acres, these plantations might all be considered as experiments.

In the rains of the year 1929, an entirely new orientation was given to planting technique by using transplants instead of direct sowing of seed; and the Chief Forest Officer (Mr. Mason) after an inspection wrote that "your Sound Island experiments have proved conclusively that transplanting padauk gives better results than direct sowing." It has been mentioned above that padauk germination is the first to appear on the field. Advantage was taken of this: and with *the first* monsoon showers thousands of padauk seedlings, most of them with just the first two cotyledon leaves, were collected from underneath the mother trees, and transplanted *as quickly* as possible on the cleared area. The point here is to put the seedlings on the ground as quickly as possible. Once this is done the further development of the seedling is very rapid, and within a month the seedlings are about 8 to 12 inches high. The lines are fully stocked with a crop of padauk, and at the end of the year the height growth averages 8 feet with a good number of plants reaching over 12 feet. With complete lines such as these, weeding costs drop perceptibly, as can be seen from the cost per acre of the 1929-30 plantation. The experience gained in the North Andamans division shows that the best results are obtained by transplanting natural seedlings collected from the forest.

Having established this fact, the next period of four years shows a definite improvement in costs.

		Rs.	a.	p.	
1930-31 ..	cost per acre	.. 110	9	0	Revenue from field *crop not credited.*
1931-32 ..	,,	.. 52	5	0	
1932-33 ..	,,	.. 28	0	0	No field crop.
1933-34 ..	,,	.. 30	0	0	

STEWART ISLAND REGENERATION; 1935 AREA
AVERAGE HEIGHT GROWTH 15 FEET

The reduction in costs is very significant. By a careful elimination of waste at every stage, a reasonable figure for costs has been arrived at, and at this cost a plantation cannot be considered to be a "financial failure."

The figures mentioned above are costs at the end of the first year. During the second and third years the costs have been as follows:

Year.		Second year. Per acre. Rs. a. p.	Third year. Per acre. Rs. a. p.	Total cost. Per acre. Rs. a. p.
1931-32 (Plantation)	..	5 0 0	3 0 0	60 5 0
1932-33 (Plantation)	..	4 8 0	2 0 0	34 8 0
1933-34 (Plantation)	..	4 0 0	1 0 0	35 0 0

Weeding.—Lines have to be kept clear of weeds till the seedlings are established. Two to four weedings may be needed during the first rains, and one or two in the second year, the growth of weeds depending on the soil. With a planting distance of 4 feet by 8 feet, or 5 feet by 10 feet, or 6 feet by 6 feet, the canopy is very close at the end of the second growing season, and, as such, except perhaps for a climber-cutting nothing would be required from the third year up to the time the plantation is due for thinnings. Plants average about 15 feet at the end of the second year and have a healthy appearance.

Natural-cum-artificial regeneration or what may be called a "controlled natural regeneration of padauk."—Advantage was taken of the experience gained in natural and artificial regeneration methods and a slight variation from the rigid planting practice was adopted resulting in a sort of *via media* between the two methods. The method is this. We start as in the case of natural regeneration by having a clean forest floor and a top canopy, but with this difference. Even among the trees of the topmost canopy, those with heavy foliage are killed by girdling. The result is that, except for a few trees of padauk on the area, there are much bigger gaps in the canopy than

are usually found on a natural regeneration area. With the rains, profuse padauk regeneration appears, probably in patches, under or round about the mother trees. These are picked up immediately and transplanted at distances of 8 feet by 4 feet or 5 feet by 10 feet. In all these planted patches of padauk, the overwood is immediately killed by girdling.

The advantage here is that while we do not lose the benefit of any natural regeneration coming up we have a more even distribution of padauk from the very start. As the overwood is girdled at once the plants put on a very vigorous growth from the start. In weeding we know exactly where to look for the padauk seedlings and help them in time in the competition with weeds or other inferior species. There are, probably, quite a number of padauk seedlings in between the lines or outside them, but even if these seedlings fail to come up either through neglect or other causes, we are assured of a good padauk crop from those that have been transplanted and tended. The result at the end of the second year is a well-grown padauk crop evenly distributed throughout the area, with a fairly good growth of white *chuglam,* white *dhup*, etc., between the lines. The manipulation of the crop now is very easy, for if we now cut back all the inferior species in between the lines we have a pure padauk crop in plantation style. Moreover, no girdling or weeding is necessary after the second year.

This was the method adopted on Stewart Island in the years 1934 and 1935, and I cannot but quote the remarks of Mr. Foster on the results obtained. Of the 1934 area he writes, "There is plenty of padauk . . . . Four weedings were done during the first year ; the first weeding of the second year is in progress but the regeneration is so advanced that I doubt if anything more than climber-cutting will be necessary after this . . . . This is the best 1934 area I have seen." Of the 1935 area he says, "The number of sturdy padauk seedlings is very marked." 1934 and 1935 areas can be converted into pure padauk areas within a year or two.

Costs.—Up to the end of the second year the 1934 area cost Rs. 20 an acre ; the 1935 area cost Rs. 9 an acre up to March 1936.

During the financial year 1936-37, practically nothing was done in the 1934 area but two weedings and girdling of the overwood were done in the 1935 area.

It may be mentioned here that between 1930-31 and 1933-34 (four years), about 250 acres of pure padauk plantations were formed, and so the experimental stage may be considered over.

In the foregoing paragraphs three methods of regenerating padauk have been considered. Firstly, by natural regeneration, by which I mean growing padauk as it occurs mixed up helter-skelter in a regeneration area; secondly, artificial regeneration by plantations, and thirdly, natural-cum-artificial regeneration. From the discussion it will also be clear that it has not been proved that a pure artificial regeneration of padauk is a "financial failure." On the other hand it appears that the third method of regenerating padauk is conducive of better results, physically and financially, than method No. 1. While thus the financial aspect of the question is not certain there are yet advantages under the last two methods which cannot be overlooked.

Advantages.—First of all under methods 2 and 3 a high degree of supervision is not necessary beyond a certain stage, namely, the second year. Under method 1, on the other hand, from the time the regeneration fellings commence right up to the complete removal of the overwood, close supervision by a trained officer is necessary. When it is remembered that every year at least 800 acres are added to the regeneration areas, and the final removal of the overwood is not made till the third year, the magnitude of the supervision necessary will be evident.

Secondly, the question of weeding. Under methods 2 and 3 we have a limited number of plants to look after and a limited area. We know where to look for the padauk seedlings, and release them from suppression, etc. Timely attention can be paid to padauk, and the optimum conditions necessary for its growth can be given. A little delay, or inattention, or want of intelligent and trained supervision has been the cause of many casualties or the lack of height growth of padauk plants. Speaking of Interview regeneration area,

Mr. Foster writes, "I was disappointed with padauk as there is not very much of it and it is a third of the height of the other species . . . ." The area should have been a thriving padauk plantation if that intelligent attention which was necessary had been given to it from the beginning.

Thirdly, the height growth. From the nature of the circumstances in a natural regeneration area, under method 1, there is a definite retardation in height and girth increments, at least during the first few years.

Finally, we come to the most important question of the manipulation of the crop to obtain mixtures by groups. The Inspector-General of Forests, in his inspection report of February 1934, observes, "If we can manage to get an average of 33 per cent. of padauk in the new crop arranged in groups, *the rest of the crop can be left as a mixture of other species.*" (The italics are mine.) That is to say that about 33 per cent. of the future crop can be of pure padauk, and the rest can be left as a mixture of the other species. It has been suggested that the best time to effect this arrangement is during the first cleaning. Experience has shown that, under method 1, owing to the uneven germination of padauk we are rather early if we do the cutting back during the first year, and if we do the cutting back in the second or third year the established plants have already suffered a set-back in growth. Methods 2 and 3 seem to be ideally suited for arranging this mixture with regard to padauk without any serious disadvantages that are noticed under method 1. If we assume that in the final crop of padauk we can get, at a modest estimate, about 50 tons to the acre, it would be possible to control the area for padauk according to our requirements.

The question, therefore, is whether it is not after all worth the trouble to go back to the plantation method of regenerating padauk or at least introduce some of the plantation technique into the "pure" natural regeneration method. Finally, I think that the last word regarding the "financial failure" or otherwise of pure artificial regeneration of padauk has not yet been said.

SOUND ISLAND—1926 PLANTATION
TREE IN THE FOREGROUND 31″ GIRTH AND ABOUT 40 FEET HIGH

[With reference to the above interesting article it may be noted that padauk is only one line of business and that the object of the management in the Andamans is not the production of only pure forests of padauk.—C.G.T.]

DEPARTMENTAL COLLECTION OF *KULLU* GUM (*STERCULIA URENS*) IN DAMOH DIVISION

BY SARDAR SAHIB KESAR SINGH, DIVISIONAL FOREST OFFICER, DAMOH DIVISION

Summary.—As a result of defective tapping resulting in a large number of trees being killed and of poor financial results, it was considered necessary to replace the lease system by departmental collection in January 1935.

In the year 1934-35, 297 maunds of gum was collected for Rs. 1,316. This quantity was sold for Rs. 3,165, giving a net profit of Rs. 1,849. In the year 1935-36, 1,604 maunds of *kullu* gum was collected for Rs. 5,113 which was sold for Rs. 11,868, giving a profit of Rs. 6,755.

The cost of collection is—

Rs. 5 to Rs. 6-4-0 per maund for white;
Rs. 3-12-0 per maund for red;
Rs. 2-8-0 per maund for black.

The cost of carting comes to 1½ pies per mile per maund for *kachcha* track and 1 pie per mile per maund for *pucca* road. The cost of grading comes to 2 annas 9 pies per maund. It has now been found that the only grading required is to separate black gum from the white and red.

The most suitable dimensions of cuts are 6 inches by 18 inches but this requires further investigation.

The average yield per tree comes to one seer per year.

The right to collect *kullu* gum in the Fatehpur and Damoh ranges on an area of 1,65,675 acres was put up to auction in the rains of 1933 and sold for Rs. 8,950 for a period of two years. During my inspection in the following touring season it was found that the terms of the agreements were being flagrantly violated by the lessees by enlarging the old blazes and making the new blazes much bigger than the stipulated size of 1 foot by 1 foot. In addition a large number of under-sized trees (below 3 feet in girth) were being blazed. (A reference is invited to my article, "Kullu Wailing," from Damoh, published in the *Indian Forester* of March 1935.) As a result of this destructive and ruinous method of working, a large number of *kullu* trees were killed throughout the division. It was, therefore,

B

considered necessary to punish the lessees under the terms of their agreement and the agreement of one of them was terminated. In view of the heavy damage done by contractors it appeared highly desirable to discontinue the lease system and to replace it by departmental collection and with this object in view the *kullu* trees were counted and serially numbered in every beat throughout the division and a detailed scheme for departmental collection was submitted in June 1934, but it was not sanctioned because the working plan was shortly to be revised. Taradehi range was accordingly put up to auction but the heavy punishment inflicted hampered the bidding to such an extent that the total amount of bids for all the three circles came up to Rs. 750 only which was considered quite inadequate and therefore rejected. While reporting the result of the auction, proposals about departmental collection were again put forward in October 1934 and Government was requested to sanction Rs. 1,500 as an experiment. In view of the refusal of contractors to offer adequate prices, Government sanctioned Rs. 1,500 for departmental collection. This sanction was received in December and the order was issued at once to start departmental blazing and collection in Taradehi range which was to be worked during the year according to the sanctioned scheme. In addition naturally exuded gum was ordered to be collected in other ranges as well. In the month of January I toured in Taradehi range and being thoroughly satisfied and encouraged with the progress made in collection, I informed Government that I would be able to give a surplus of Rs. 2,000 before the end of March, and requested the Government to sanction Rs. 5,000 for departmental collection in 1935-36 and to allow me to continue the work in Taradehi range as it had not been worked properly. I felt quite confident in promising a surplus of Rs. 7,500 during 1935-36. In 1934-35, 217 maunds of gum were collected and carted to Damoh at a cost of Rs. 836-0-9 as detailed below :

Range.	*Maunds.*	*Cost.* Rs. a. p.
Taradehi	182	722 13 3
Other ranges	35	113 3 6

Rs. 25 were spent in cleaning and grading in three different qualities as under :

	Maunds.	Seers.
1st quality, white	37	20
2nd quality, red	139	0
3rd quality, black	28	38

The bidding for the gum was very brisk at the auction held on 27th February 1935 and adequate prices were obtained as under :

Qualities.	Maunds.	Seers.	Price per maund obtained.			Total.		
			Rs.	a.	p.	Rs.	a.	p.
1st quality ..	37	20	20	2	0	754	11	0
2nd quality ..	139	0	11	12	0	1,633	4	0
3rd quality ..	28	38	6	0	0	173	11	3

Another lot of 97 maunds of gum was received in the month of March 1935 which was graded as under at a cost of Rs. 8 :

	Maunds.	Seers.	Chataks.
1st quality	27	0	0
2nd quality	43	18	0
3rd quality	27	27	8

This lot was put up to auction on the 25th March 1935, but only 2nd and 3rd quality could be sold at Rs. 10-11-0 and Rs. 5 per maund respectively.

The total amount of sales during 1934-35 amounted to Rs. 3,164-9-6 and the total expenditure was Rs. 1,315-13-1, thus there was a surplus of Rs. 1,848-12-5 plus unsold quantity of class I gum worth Rs. 550.

Proposals about continuing departmental collection in 1935-36 in Taradehi range were approved by Government and a sum of Rs. 6,000 was sanctioned. During this year the operations were active only in Taradehi range where trees were allowed to be blazed, while in other ranges only the naturally exuded gum was collected,

The total quantity of gum collected up to 15th February 1936 amounted to 1,046 maunds 2 seers and 8 chataks as detailed below:

		Maunds.	Seers.	Chataks.
1.	Taradehi (where trees were blazed) ..	434	11	4
2.	Damoh (where only naturally exuded gum was collected) ..	249	29	4
3.	Tendukhera (where only naturally exuded gum was collected) ..	149	21	4
4.	Singrampur (where only naturally exuded gum was collected) ..	78	10	0
5.	Fatehpur (where only naturally exuded gum was collected) ..	134	10	12

The whole lot was graded in three qualities as under at a cost of Rs. 188-8-3:

	Maunds.	Seers.
1st quality	371	0
2nd quality	366	31
3rd quality	262	10

It is yet too early to form an accurate estimate as to what proportion of each quality of gum could be had from uncleaned material collected in the forest, but taking the average of the last two gradings we can roughly expect to get about 32 per cent. of white, 40 per cent. of red and yellow and 27 per cent. of black, 1 per cent. being lost in cleaning and grading.

This lot was put to auction at Damoh on 19th February 1936 and sold as under:

	Rs.	a.	p.	
1st quality	14	5	0	per maund.
2nd quality	10	6	0	,,
3rd quality	5	1	0	,,

Another lot of 47 maunds was received before the 25th March 1936 and as an experiment suggested by merchants it was put to auction without grading and cleaning and was sold at Rs. 12-8-0 per maund against the average of Rs. 10-8-0 per maund obtained when sold in

February last after cleaning and grading. This shows that it is unnecessary to spend anything for grading and cleaning, but the higher average may possibly be attributed to better demand and keen competition among the bidders and the stuff being better. In addition I received nine maunds of black gum from one of the range officers which was separately put to sale and sold for Rs. 37-3-6. Thus the total amount of sale for the year 1935-36 amounted to Rs. 11,868-8-6 with an expenditure of Rs. 5,113, giving a profit of Rs. 6,755, which is Rs. 1,943 more than the highest amount received per year under the lease system.

2. *Rates for collection.*—Rates for collection vary according to the quality of the gum as under:

White	2 annas to 2 annas 6 pies per seer.
Red	1 anna 6 pies per seer.
Black	1 anna per seer.

3. *Shape of blazes.*—The present size of a blaze is 6 inches by 18 inches and this is healed up by occlusion in 12 months. There should be only two blazes on the opposite sides of a tree. They should be 4 inches by 8 inches to start with and gradually extended up to the above dimensions in a period of 12 months. The most suitable size of a blaze is yet to be ascertained and further research is in progress.

4. *The cost of carting.*—This varies according to the nature of the roads and is on an average 1 pie per maund per mile for metalled roads and 1½ pies per maund per mile for the *kachcha* cart tracks. A cart carries 10 bags—each bag weighing 1½ maunds—on *kachcha* road, while on *pucca* road it can carry about 12 bags weighing 16 maunds.

5. *Cleaning and grading.*—The total expenditure on cleaning and grading 1,087 maunds of gum at headquarters comes to 2 annas 9 pies per maund. The above quantity was graded into five lots as under:

	Maunds.	*Seers.*
1st quality, white	371	0
2nd quality, red	366	31
3rd quality, black	262	10
4th quality, *chura*	63	27
5th quality, dust	24	0

On an average 35 coolies can clean and grade about 30 maunds of gum every day, working eight hours per day.

6. *Damage.*—Though reopening of the old blazes is strictly prohibited but with a large number of coolies employed it is not possible to enforce this prohibition altogether. This, however, is insignificant as compared with the excessive damage done under the lease system. The best way to minimize the damage is to reward beat guards, who supply reasonable quantities of gum without appreciable damage in the beats and punish severely those in whose beats heavy damage is found.

7. *Potential value of the operation with regard to the whole Province.*—Of all the divisions I have seen so far I consider that the Damoh division contains the largest number of *kullu* trees—roughly enumerated as under :

1.	Taradehi	..	71,848
2.	Tendukhera	..	50,752
3.	Damoh	..	10,018
4.	Fatehpur	..	15,627
5.	Singrampur	..	22,170

Naturally we cannot expect as much yield of gum from other divisions as Damoh, but there are some divisions, like Seoni, Jubbulpore, Saugor, Betul, Melghat and Khandwa, where the number of trees is sufficiently large to justify the departmental collection and, roughly speaking, if we place the yield of each of these divisions as one-third of that of Damoh we will be collecting about 352 maunds of gum in every division annually which might yield a gross revenue of Rs. 4,400 and net profit of Rs. 2,123.

8. *Observations.*—(1) It is not certain as to how long the natural exudation continues after the stoppage of blazing, but so far it has been observed it still continues in the areas of which the leases expired about two years ago and from the rate of present exudation it appears that it may continue for a couple of years more. As the new blazes 6 inches by 18 inches are likely to be healed up within a year or so after the stoppage of blazing it would mean that while one range will

be taken up every year for active operations where blaze is allowed, naturally exuded gum will also be collected at least in one of the remaining five ranges.

9. *Season for collection.*—(2) It has been observed that exudation is very copious and gum exuded is usually of a white colour in the month of September, October, April, May and June. Strictly speaking the exudation continues throughout the year, but in the rains it becomes black in colour and some of it is washed away. The collection is done from October to June.

10. *Miscellaneous.*—It is generally believed that red barked trees give a better yield than white barked ones and that exudation is much better on slopes. It is also noticed that the quality of the gum deteriorates with excessive tapping of trees.

(*ii*) From the enquiry made at the last auction it appears to be desirable to auction the gum collected from February to June (which is better in colour) in the month of June and that collected from September to January in the month of January.

(*iii*) The Taradehi range Bansi beat with 1,300 trees gave the best yield of 58 maunds and this gives us an average of $1\frac{3}{4}$ seers per tree, while Barbata beat with 2,860 trees gave the lowest yield of gum which gives an average of $4\frac{1}{2}$ chataks per tree per year.

11. Last year *kullu* gum thefts were the order of the day throughout the division as mentioned in the note referred to above, but as a result of strong action taken by the Revenue authorities in the way of punishing the Malguzars and Malguzari contractors, and the adequate punishment accorded in cases prosecuted by the department, matters have improved considerably, but still there is much to be desired. The local Government has, therefore, been approached with a request to issue a notification imposing restrictions on the movements of gum in the district as was done in the case of lac.

A SUNDARBANS TIGER

By Y. S. Ahmad, I.F.S., Bengal.

If you want a tiger, "go to the Sundarbans" is the usual answer—but it is not always so. A tiger there, as in all other places, is a question of luck—*kismat* if you like. You may search, wait, or display a Job-like patience, but never one will greet you—yet some have tigers simply thrust on them. Such was the case in the tale I heard.

It was the summer of 1934 in the Sapla Coupe of the Sundarbans. The Coupe officer's little cottage was situated on the banks of the Sapla Khal, very near the angle where that waterway meets a much smaller stream—the Khudiram Khal. The cottage, raised about 10 feet from the ground, was a small two-roomed one with a verandah on one side, and this continued in front of the kitchen, which met it, at an angle. As is usual in the habitations of the people in these areas, the walls and the roof of this abode were constructed of *golpata* (*Nipa fruticans*), an important produce of the Sundarbans' forests. The only way of entrance and exit was by means of a staircase attached to the verandah in front of the kitchen. Men like publicity, so do tigers sometimes, for the D. F. O. on his tour on that occasion had anchored his launch not far from the Coupe.

The evening had set in, the two Forest Rangers had returned home, and having bathed to get rid of the dirt and mud collected in their day's work, had hung their shirts on the railings of the verandah and retired after dinner to their respective rooms and bed. Each man was accompanied by his servant—and these latter having also spread their beds on the floor were soon asleep. Peace reigned supreme.

While men slept, the kings of the forest started their midnight prowl. It was about 3 a.m. a tiger more daring than most, decided to investigate the contents of the cottage. Slowly and softly, as becomes his race, the tiger climbed up the stairs, passed the verandah along the kitchen and came near the rooms which sheltered his prey.

He smelt human flesh, and deemed it good, and straight away started his attack. He found a pair of boots—apparently wet boots left outside by the wearer—chewed them, and not finding them too tasty, continued his investigations. He commenced to scratch away at the *golpata* very near the bed of the servant sleeping in room No. 1. Fortune favoured him, for the man lying there was as deaf as the proverbial doornail. He heard no sound. The tiger continued his efforts, and then with his paw, which had found a way in, clutched at something, and getting no resistance started pulling, curious perhaps to know what the prize was. So it was not till the poor man, finding his bed slipping from under him--for it was that the tiger had grabbed—awoke from his slumbers. Imagine his horror, seeing by means of the dim hurricane lantern that hairy paw. He immediately became active and with the alacrity of the terrified sprang up and woke his master with: "A tiger, a tiger!" The Range officer jumped up and quickly ran into the adjacent room, through the connecting door, for his gun, proceeded to the outer door and fired. Meanwhile the tiger, hearing the noise, beat a retreat too, running down the passage. Though the range was close, the bullet hit, but did not kill him. The wounded tiger with a loud roar leapt off the verandah, and in his leap entangled himself in a shirt, and fled shirt and all into the jugle, leaving in his trail a pool of blood. It is true the tiger escaped, but sleep too vanished from the eyes of the men, and they kept awake the rest of the night full of apprehension of the shrouded tiger.

Next morning, as soon as day dawned, the Divisional Forest Officer was told the tale and under his guidance three batches of men, composed mainly of Barsakati Bawalies (wood-cutters), noted for their daring, set forth in quest of the wounded animal. At about 8 a.m. one of the parties came across the tiger near the Khudiram Khal, about half a mile from the Coupe officer's cottage, nursing his wound. The leader fired and hit him, even so the tiger jumped into the river and sank. The khal was a small one, but as it was nearly high water it was difficult, in fact it seemed impossible, to recover the beast from its watery grave. Someone, however, had a brain-

wave; a net was put across the khal to prevent the dead animal being washed away. Once again the search started and continued—men waded, dived, punted their boats about—and it was well on to 4 o'clock in the afternoon before the tiger was located. Five men dived down and with difficulty, yet with joy, brought the dead king of the forest to land. It was 6 o'clock when the party returned to the camp.

These are some of the excitements of the Sundarbans. Yes, if you are lucky, go to the Sundarbans for your tiger.

EXTRACTS

INDIAN TIMBERS

*CHAPTER IV

The value of imports into the United Kingdom of timber classed as unmanufactured during 1936 was £43,567,536 as against a value of £35,516,257 in 1935. Imports of hardwoods (hewn and sawn) rose to 861,000 tons (of 50 cubic feet each), valued at £7,451,984 in 1936 as against 777,000 tons, valued at £6,358,459 in 1935.

Details are not yet available of the quantities of timber, other than sawn teak imported from India. The quantity of sawn teak imported from India during 1936 rose to 45,500 tons, valued at £894,800 as against 35,760 tons, valued at £638,000 in 1935. This is the highest import of sawn teak since the war and in point of value places the imports of hardwoods from India second, the imports from the U.S.A. being the largest both in quantity and aggregate value.

Sales of timber through the medium of this office during the quarter under report were 815 tons and deliveries against previous sales were 248 tons as against 141 tons and deliveries 299 tons in the previous quarter. The increase is under gurjun. For this the Railway demand is responsible.

Imports of plywood into the United Kingdom during 1936 rose to 14,292,347 cubic feet, valued at £4,127,375 in 1936 as against

* Extract from the Report of the Indian Trade Commissioner, London, for the quarter ending December 1936.

12,484,201 cubic feet, valued at £3,499,946 in 1935. Practically all this plywood comes from outside the British Empire.

The value of veneers imported increased from £766,403 in 1935 to £851,597 in 1936.

The new escalators at Moorgate Underground Station have been constructed as a permanent exhibit of Empire hardwoods. Some thirty different hardwoods have been used including Indian laurel, Indian rosewood, Indian silver grey wood and teak, figured and plain. Each timber is labelled with its name. Unfortunately the woods are only used in the form of veneers. The escalators have aroused considerable interest and as a result the London Passenger Transport Board has decided to panel the next four sets of escalators with Empire woods. Indian laurel will be used for the escalators at the Post Office Station.

HISTORY OF THE MANAGEMENT OF THE DARJEELING FORESTS

BY MR. E. A. MODDER, DEPUTY CONSERVATOR OF FORESTS.

The Darjeeling forests include the first reserved forests created in Bengal in 1864. Those near Darjeeling were worked departmentally from 1865 to 1868 and on the permit system from 1869 until they came under Manson's Working Plan from the year 1892-93. The permit system, with a fixed price per tree, led to the removal of all best trees; and hollow and defective trees were allowed to accumulate in the forest. This largely accounts for the scarcity of good trees of any valuable species in the more accessible blocks.

2. Manson's plan prescribed a rotation of 160 years in five periods. Periodic Blocks II to V were to be worked over by improvement fellings. Periodic Block I was to be regenerated in 32 years by taking out half the crop in a regeneration felling and the remainder was to be left as a shelter-wood over the young crop which, it was anticipated, would consist of natural seedlings supplemented by sowing and planting. The shelter-wood was to be removed later in a final felling.

3. It seems now probable that Manson's plan would have worked fairly well had regeneration fellings been made, in all cases, in areas that had escaped heavy damage from grazing where natural reproduction could reasonably be expected, and had the first fellings taken out about two-thirds of the original crop, including all the biggest stems with widespreading crowns. What *actually* happened was that two-thirds of the original crop was left to be taken out in the final fellings with the result that excessive damage was done to plantings made after the first felling.

4. Osmaston, when revising Manson's plan, stated, "The great drawback to the present system is, undoubtedly, the very serious but unavoidable damage done to poles and saplings of the advance growth and first planting at the time of the final fellings. This would be naturally reduced if a larger proportion of the stock, say two-thirds, were removed in the first fellings, and would be obviated altogether by regenerating in a single felling; and but in this case, in order to give the young transplants the necessary shelter in their youths, it would be necessary to fell in strips or comparatively small groups, otherwise we should obtain a branchy, stunted growth, unsuitable for timber similar to that which has resulted from the clear fellings which were carried out in Senchal V. . . . "

5. Grieve's plan which was in force from 1912 to 1917 prescribed the coppice method in certain limited areas, and the removal of the mature crop in groups from the remainder of the area closed to grazing, taking advantage of such advance growth as already existed.

His chief reasons for altering the method of treatment prescribed by Manson were:

(1) Serious damage in the final felling to the young crop.
(2) Inability to take full advantage of natural reproduction which is fairly good in places.

6. Grieve's plan was abandoned on the grounds that coppice growth was unsatisfactory, and that the supervision and inspection of the various operations, from fellings to planting and tending in numerous groups scattered all over the forest, was difficult.

Recent inspections have revealed the fact that the crop in some of Grieve's coppice coupes in Mahaldaram is very good indeed and superior to some of the adjoining *taungya* plantations raised under Baker's plan. There are, however, other coppice coupes, where fellings were made before the forest had recovered from the effects of grazing, in which the crop is distinctly bad and consists mainly of inferior *kharani* poles.

7. Since 1917 the method of clear felling followed by planting has been in force. *Taungya* cultivators were recruited in large numbers in 1921 and 1922 and most of the plantations since then have been raised in conjunction with *taungya* cultivation.

Fellings in Ghumpahar and Mim-Nagri ranges from 1912 to 1920, i.e., the groups under Grieve's plan, as well as fellings made to amalgamate these groups from 1917 to 1920, had all to be replanted in 1921 and 1922. It was found that most of these areas were blank when *taungya* cultivators were employed to raise field crops to keep down weeds.

8. Prior to the introduction of *taungya* cultivation, plantations were a troublesome and costly business, and there were many disappointments and failures. The principal reasons were :

(1) Bad planting and not planting at the proper time due to lack of skilled labour and difficulty in procuring labour when required.

(2) Exceptionally heavy growth of weeds in most plantations which suppressed and killed many seedlings, made cleanings expensive and inspection difficult.

(3) Damage by barking deer which were afforded excellent shelter in the heavy undergrowth. They used to walk along the cleared plantation lines and do considerable damage although each individual seedling was fenced with stakes.

9. Considerable difficulty was experienced in recruiting *taungya* cultivators in Darjeeling division at the beginning. Forest Rangers and other subordinates would not help ; it was only after a

gazetted officer, T. M. Coffey, was put in charge of Ghumpahar range that we succeeded in getting cultivators in large numbers.

With the introduction of *taungya* cultivators, coolies on daily labour ceased to be employed on plantations in large numbers and the handling of large sums of money by subordinates was no longer necessary. Inspection became easier, damage from barking deer diminished, and plantations were more successful and cheaper, due mainly to a supply of skilled labour which was always available when wanted. I would like to stress these points if the question of abolishing *taungya* cultivation, which has admitted disadvantages, is considered.

The disadvantages of *taungya* cultivation in these hills are:

(1) Erosion and deterioration of the soil.

(2) Unavoidable destruction of advance growth due to uprooting and burning when the area is being prepared for cultivation.

10. Plantations raised with *taungya* cultivation, especially on the tops of spurs, do not look as healthy as those raised without *taungya*. None of them compare favourably with the excellent results obtained near Rangirung under Manson's plan, or the coppice and natural reproduction in the coppice coupes near Tung under Grieve's plan. It is very probable that the results in those two places are so good because these areas show no signs of ever having been *jhummed*, and fellings might have been made after the areas had recovered from the effects cf heavy grazing.

11. I am of opinion that coppice, with wide planting of a species such as *Birch*, will give better results than the present method, over the greater portion of the Mahaldaram Fuel Working Circle below 7,000 feet, provided the most troublesome weeds are pulled up by hand at the beginning and fodder-cutting is properly controlled. A small experiment, started last March on these lines in Mahaldaram III, looks very promising.

12. Dungdungia block, which was included in Short Rotation Fuel Working Circle under Baker's plan, has been transferred to the *Cryptomeria* Working Circle in the current plan, on the grounds that *Cryptomeria* is the only species likely to grow satisfactorily in this

area. I quite agree that *Cryptomeria* is the only species we know of that can be grown in a place like Dungdungia under the present system in force, but it is possible to grow species, such as ***Buk***, ***Sungre Katus***, etc., if a system is introduced that will give the young seedlings shelter. In support of this statement I give the following extract from Grieve's plan :

> "Dungdungia Ridge.—Reproduction of Oaks and *Champ* is good along the top of the ridge, and *Kawla* is coming in below."

13. A few small groups made in Dungdungia under Grieve's plan contained some natural seedlings and many transplants, but they all died due to exposure shortly after the groups were amalgamated. Attempts made to re-stock the big clearings in this block with species such as ***Buk***, *Sungre Katus*, *Kapasi*, *Arupati*, etc., were unsuccessful, and we had to fall back on *Cryptomeria* as the last resort, because it was the only species that could stand exposure in this block.

In spite of the fact that *Cryptomeria* is a bad firewood and the adverse report from Dehra Dun regarding the quality of Bengal grown *Cryptomeria* timber, it is not unlikely that we may be committed to grow it on a larger scale than even at present, unless the existing method of treatment for places like Dungdungia is altered.

14. In the current working plan it is stated that an exploitable girth of 8 feet for *Champ* and *Walnut* and 6 feet 4 inches for other species will yield timber sufficiently large for all purposes. Manson, on page 107 of his plan, says, "***Buk*** trees of 7 feet in girth at 4 feet from the ground have generally a ring of sapwood 4 to 6 inches wide, *i.e.*, 51 to 70 per cent. of the sectional area at that height; and *Champ* trees of that girth have generally a ring about 3 to 4 inches, *i.e.*, 40 to 51 per cent. of the sectional area. With a girth of 9 feet the sapwood in *Champ* is reduced to about 1¼ inches in width, say, ·14 of sectional area ; and ***Buk*** rather more, about 2 inches in width or ·22 of the sectional area at the height named." Again on page 29 Manson says, "It appears that 9 feet girth was the size most in demand, indicating that at these dimensions the trees combine the largest volume of timber with soundness of quality."

15. There were no complaints in years gone by regarding the quality of building timber from these forests because it was good and durable. In recent years our hill timbers have been looked on with suspicion and there has been a growing tendency to import teak or timber from the plains. I realise that little can be done at present to improve the quality of timber coming into the market, because good mature trees are very scarce. There is, however, no justification for deliberately fixing a size and rotation for the crops we are now raising, that we know will yield only inferior and immature timber.—(*Proceedings of the Forest Conference held at Darjeeling from 12th to 17th October, 1936.*)

KAMRUP METHOD OF NATURAL REGENERATION OF SAL AND THE POSSIBILITY OF ITS APPLICATION TO BENGAL

By R. I. Macalpine, Esq., Deputy Conservator of Forests, Silviculturist, Bengal

PART I.

The sal forests of Kamrup came under the spell of fire protection in common with other areas throughout India and Burma during the period 1873—1915. While, possibly, fire protection was not so complete as elsewhere, its results were clearly indicated by an evergreen invasion. In 1908-1909 "improvement fellings" aimed at the removal of mature and over-mature trees were commenced and it was noticed that a sprinkling of evergreen species had appeared but were not in such quantity as to be considered a menace. Improvement fellings were continued until 1914 when it was made obvious that a direct and immediate result of continued fire protection was the change from the original fire sub-climax of a sal-thatch association to one of sal-evergreen. Where, in 1909, evergreens were comparatively scarce, in compartments where light had been introduced by the improvement felling, there was now an evergreen second storey 8 feet to 10 feet in height, and a thick covering of evergreen shrubs

and weeds. In the compartments which had escaped improvement fellings, there were similar results in varying intensities. There were still areas outside the Reserves in the thatch stage, and here advance growth was abundant, whereas in the evergreen areas it was absent. There was no doubt in the minds of those responsible for the management of the forests that all was not well and the courageous step of abandoning fire protection was taken in 1916, and, wherever the evergreen invasion had not made it impossible to put a fire through, annual burning of the forests was systematically introduced. Where this was successful the evergreen retrograded to the thatch association, and again, sal advance growth began to appear. In those areas where evergreens had taken charge and burning was not possible, the evergreen invasion continued to increase in intensity and sal advance growth was non-existent.

Observations both in Reserve Forest and Unclassed State Forest led Milroy to the conclusion that natural regeneration of sal was both possible and practicable and a working plan was compiled by Bor which laid down that the natural regeneration system was to be adopted.

Briefly his plan prescribed the following technique :

(*i*) Uniform and systematic burning. In areas where evergreens, or Pollinia had taken hold, burning was to be late, *i.e.*, the burn was to be as hot as possible, whereas where grasses (other than Pollinia) formed the chief ground cover, the burning was to be done early (*i.e.*, the burn was to be as cold as possible). The object of this prescription was to reduce the ground cover to one of pure thatch.

(*ii*) In P. B. I, wherever sal advance growth was observed, or where the undergrowth was favourable (*i.e.*, where *Imperata arundinacea*, Coffea or *Clerodendron*, *etc.*, existed), the canopy was to be opened in strips or groups. A limit to the extent of such openings was fixed, in that no group or strip would exceed in diameter or width, respectively, one tree's height.

In P. B. I., the burning prescription was the same as elsewhere.

He noted that almost everywhere in P. B. I, sal advance growth existed, and that thatch (*Imperata arundinacea* or Pollinia) formed the chief ground cover.

In 1929 the prescriptions of the plan were brought into operation; groups and strips were opened up, combined with the cutting of evergreen undergrowth as it appeared.

A great deal of adverse criticism was levelled at the prescriptions of the working plan and in the course of working to obtain the yield groups and strips often exceeded the limit of one tree's height, and (what subsequently proved a most important operation) tending operations, including the cutting of evergreens, were not persisted in. Further, the discriminatory early and late burning was not applied to P. B. I in accordance with the definite prescriptions to this effect laid down in the working plan. Thus in thatch areas fierce fires resulted by late burning which it is believed completely wiped out advance growth which was known to have existed. The lack of tending operations caused in the openings a fresh influx of evergreen which made it impossible to burn. Further in many cases trees marked for felling were not cut by contractors and were not departmentally felled.

In 1932, after an inspection of the areas by the Central Silviculturist and the Inspector-General of Forests, it was considered that the plan had failed in its purpose of restocking the area by the natural regeneration system and they advised a cessation of further fellings.

The author of the plan, Bor, visited the areas and was not long in pointing out that his prescriptions had not been adhered to. In 1933 Milroy and Jacob inspected the P. B. I areas in view of Bor's objection and decided to carry on his plan in its entirety.

Stress was laid on the importance of subordinating the obtaining of the yield to the progress of regeneration (*i.e.*, strictly adhering to the one tree's height limitation), the felling of *all* trees marked, and the cutting back of evergreen undergrowth. There was an immediate response, and the pessimistic prognostications resulting from the

Central Silviculturist's and Inspector-General's visit, were replaced by a feeling of justifiable optimism.

In 1934, where the floods of that year did not completely destroy seedlings and seed, the improved conditions resulting from the treatment accorded to the areas coincided with a more healthy stock of advanced growth and considerable recruitment of seedlings. Evergreens were brought under control, and thatch began to occupy the greater portion of the area.

"Technique" developed rapidly. In many areas Eupatorium was rampant. Cutting, if anything, increased its vigour, and it was found that pulling up in the rains had an immediate effect, was easy and not excessively expensive. Repeated cutting back of shrubs, and pollarding of bigger stems, for a few years, reduced their vitality quickly, and removed the danger of suppression of sal.

The importance of early burning where thatch was present was soon realized. It was obvious that fires late in the dry weather were inimical to sal, and a most intensive system of burning was introduced. This requires special mention in more detail. The orders in force are that where thatch exists the burning must be completed by the 15th January at the latest. To do this, areas which have the slightest chance of burning are burned as early as November. The first burn is naturally patchy and large areas remain unburned. The burning is then continued at fortnightly intervals, each unburned patch being burned as it becomes ready, and so on until the burn is complete. As may be imagined this is a laborious task and burning has to be assisted by torches, etc. Again where thatch is luxuriant, before burning it is pressed down by gangs of coolies. The work in Kamrup is all done by forest guards, and the results obtained reflect enormous credit on the staff.

Another item briefly referred to above is the vigour and dispatch with which the Eupatorium problem has been tackled. Anyone familiar with the Chittagong districts will realize the magnitude of the task of uprooting Eupatorium, yet this has been done over large areas with complete success and is now no longer considered an eradicable menace.

So far reference has only been made to P. B. I areas. The extension of operations to other areas, particularly P. B. II, has to a great extent been limited by the provisions of the working plan restricting the yield to P. B. I. Apart from this, it is only within recent years a demand for smaller trees and poles has arisen. It is now proposed to allocate, and commence operations in P. B. II areas.

Another important development has arisen. The plan prescribes what corresponds to group regeneration fellings. This was a wise precaution in view of the fact that at the inception of the plan it was not definitely known that a system of natural regeneration would be successful. The disadvantages, in comparison with a uniform method, are obvious, in that work is diffused over a large area, and when P. B. I is completely regenerated it would consist in any one unit of area, of areas carrying different ages of stock. From observations recently made it appears that the system now in operation is capable of being applied uniformly and this is now being done with very fair success.

Considerable progress in regeneration has been made, but it would be unsafe to say that Kamrup's troubles are over, and further research is indicated.

Certain areas have now been completely regenerated and transferred to P.B.V (the plan provides 5 P.Bs. of 20 years each of which only P. B. I is allocated) and careful fire protection is being carried out. This too is a marvel of intensive organization, fire watchers being stationed on bamboo "tongs" along the whole boundary and at other strategic points, during the whole fire season.

Again the question arises whether regenerated areas should be coppiced or retained as they are. It would appear from a comparison of both, that coppicing, while it retards establishment for a year or two results in excellent clean growth, and the stock does not present that rather "gnarled" appearance, and crop of epicormics, so typical of sal, brought up under fire.

Again the creeper problem, while it has not yet become formidable in Kamrup, is one that may cause trouble. In several localities *Mucuna pruriens* is noticeable and may constitute a real menace,

I am convinced however that the success obtained with the control of Eupatorium is a pointer to the method which is most likely to be successful for creepers, namely, pulling up in the early stages.

It should be mentioned that grazing is a factor the effect of which has not been definitely estimated in the natural regeneration system in Kamrup. Practically the whole area is open to grazing to a greater or less intensity, varying with the size and situation of local *bastis*. All that can be said definitely at present is that light grazing does not inhibit the establishment of sal reproduction, the indication, if anything, being that it may be beneficial, in that as long as there is thatch, sal is not browsed and the thatch is reduced both in vigour and luxuriance, to allow the sal to get well up in a short time. Heavy grazing is however deleterious, the ground is trampled hard, and thatch does not establish itself—here the solution (for solution it is) is fencing by a few strands of barbed wire—the response of both thatch and sal being almost immediate.

I have stated that the object of both burning and opening the canopy is to replace the evergreen ground cover by "thatch." "Thatch" in Kamrup is here meant to cover two types of grass known locally as *Khair* and *Ulu*. Specimens of both have been identified as *Imperata arundinacea* perhaps best known to most of us as *Sunn* grass. I confess the identification of both as this species was a surprise, as they appear entirely different. *Ulu* is a short fine-leaved form normally never attaining more than 24 inches in height, whereas *Khair* is normally some 4 feet high and may in wet areas go up to 7 feet.

In view of Dehra Dun's identifications these two types must be growth forms of *Imperata* and the reason for the variation is to be studied.

The importance of this is that *Ulu* is much less destructive to sal than *Khair*; a burn in the lower growth form is much less severe and its suppressing effect is less and consequently the establishment of sal reproduction is facilitated. It is therefore the aim of the Divisional Forest Officer, Kamrup, to encourage *Ulu*. In an area where both forms exist, an early burn goes through the finer *Ulu*

first, the *Khair* not burning completely and new shoots do not appear immediately. The burned *Ulu* root stocks, however, put up luxuriant fresh shoots and these having a longer growing season tend to oust the *Khair*. This is Mr. Jacob's opinion but has not been proved.

I am inclined to believe that grazing plays a part in this connection. In Bengal *Ulu* is usually associated with grazed lands as is typified by the village site of Mech Basti, and the khas land bordering the Reserves at Damanpur. Does constant cropping by cattle induce a finer form of *Imperata* ?

PART II.

APPLICATION TO BENGAL.

Perhaps before entering into the question of the possibility of the application of the Kamrup method to Bengal, we should reflect why this system should be considered at all.

All our sal working plans prescribe clear felling and planting, but as the Conservator of Forests has pointed out, this prescription fails in that in no division has the progress of artificial regeneration been up to prescription, with the consequence that at the present, or even a greatly enhanced, rate of artificial regeneration we shall not be able to cover the total area within the prescribed rotation.

The following figures in this respect show the position in the sal divisions :

	Total area prescribed up to 31st March 1936.	Total area regenerated.	Percentage of (*a*) to (*b*).
	(*a*)	(*b*)	(*c*)
	Acres.	Acres.	Acres.
Buxa ..	5,400	2,387	44
Jalpaiguri ..	5,048	1,551	31
Kurseong ..	5,182	2,694	52

It will be seen, therefore, that long before we may reasonably expect to cover even P. B. I our growing stock will be over-mature. In fact, taking the rotation as fixed in the working plan as 80 years, on proportionate calculation in terms of percentage of prescription to

work actually done the rotation will be increased from 240 years in Jalpaiguri to 160 years in Buxa Division. Apart from this, it is the considered opinion of competent observers that the presence of evergreen is responsible for the unhealthy appearance of our sal, and that mortality may seriously increase. While artificial regeneration as a result of the development of our technique is both certain and sure, in certain areas at least, we have reached the maximum intensity of progress in re-stocking that we can reasonably expect for some many years, and it seems most important therefore that we should consider supplementing *taungya* by natural regeneration method if not actually adopting natural regeneration as the principal method and supplementing it by artificial.

Before entering into any discussion as to the practicability of applying the Kamrup method to Bengal, a comparison of the localities may be made.

Firstly, Kamrup exhibits generally a drier facies than that obtaining in Bengal. The rainfall is considerably less, only 70 to 80 inches per annum.

Secondly, the majority of the areas in Kamrup now under natural regeneration, bear almost pure stands of sal, of a much younger age probably than the majority of our Bengal sal. It is this latter which has made the allocation of periodic blocks difficult in Bengal, such allocation having been made not so much on consideration of age, but on a numerical division of a quarter of the total area ; and on markets. Much of our future P. B. II contains sal, no younger than that in P. B. I.

Thirdly, fire protection during the period 1873—1915 was not so effective in Kamrup as in Bengal, and probably the fire sub-climax of "thatch" had not completely been replaced by the evergreen association. In Bengal the position in many parts is totally different, but it is nevertheless encouraging to note that in our plantation burning experiments, thatch is appearing where nothing but such heavy evergreens as "Bote pan" existed before (*e. g.*, Mendabari).

Fourthly, sal does not occupy such varied localities in Kamrup as in Bengal. In fact Kamrup exhibits only two sal types corresponding more to Dacca-Mymensingh rather than Northern Bengal types. They have no problem of "Bhabar." Each of our types therefore may require modifications of the Kamrup method.

Again the question of labour will have to be considered. Kamrup is fortunate in having a source of labour, practically throughout its whole area. We shall find difficulty in this respect, but I do not consider it insurmountable, and in any case the position cannot be worse than what now obtains as a result of our failure to work up to prescription.

THE YIELD.

Perhaps of supreme importance in this connection is whether the yield prescription of our working plans will be upset by the method suggested.

It will be obvious that we cannot lay down any volume yield for the operations which depend entirely on silvicultural markings, and while it cannot be definitely stated how the regeneration fellings will turn out, it is nevertheless a fact that the present plans prescribe that the yield will firstly be obtained from clear fellings, secondly from dry markings and lastly only from selection fellings. It would appear therefore that selection fellings will be replaced by regeneration fellings and further judging from Kamrup, the yield from regeneration fellings may be even greater, at least to begin with, than that now obtained from selection fellings.

It would appear to me in view of the facts enumerated above that we should now attempt to allocate P. B. II and commence natural regeneration operations in this as also in the areas of P. B. I which cannot hope to come under the axe within the period now remaining.

The Divisional Forest Officer, Jalpaiguri, informs me that in Apalchand, he can, if permitted, work up to prescription. It would be advisable to survey the position in light of this in other sal working circles.

It would appear to me that even if we have only partial success, we will have added some young sal to our stock, whereas if we have complete success the gain will be immense. Apart from this the effect of controlled burning is cumulative, and there can be no doubt that the condition of our areas will be improved as a result of the proposed burning.

It would not be wise to dogmatize on the application of the Kamrup method to Bengal. There are numerous types and sub-types of sal within our area apart from the broad division of types laid down by the Sal Commission. Some of these will be extremely difficult, *e.g.*, Upper Bhabar; some even now show promise that success may be obtained, *e.g.*, Sivoke and Apalchand, and it will be necessary for some years to keep detailed observations on experiments which we propose to originate this cold weather.

At this stage, perhaps, it may be asked what results have been obtained so far with our experiments in natural regeneration? Four regular experiments were laid out some five to six years ago, two in Upper Bhabar, and two in Tista Valley.

These may be briefly described here :

Raimatong.—A large area of five miles burned annually for the past six years. Results: No established regeneration. Here Pollinia is abundant and luxuriant, and this without doubt prevents the establishment of sal. Apart from this sal is somewhat scattered, and miscellaneous species predominate. It was hoped that burning alone would eventually eradicate Pollinia and thatch replace it, but hitherto the incidence of thatch is small. It is nevertheless clear elsewhere that thatch tends to replace Pollinia only in openings, and the indication is that opening of the canopy is essential, and that this has not been sufficient in this area.

Future treatment suggested—opening of canopy and burning.

It may also be essential to broadcast sal where mother trees do not exist in sufficient quantity. I do not propose rains weedings here yet, as labour is difficult. The Divisional Forest Officer, however, is introducing graziers and the results of grazing alone will be observed. This may supply in due course labour sufficient to do rains weedings,

Santrabari Plot 16.—An area of five acres, cleared of all Kukat in 1930, since burned annually. Sal mother trees on ridge. There is a certain amount of unestablished sal reproduction, but the original treatment of cutting miscellaneous undergrowth was not continued in subsequent years.

Future treatment.—Continual burning and cutting of undergrowth as per Kamrup method. The area is, however, too open now (*c.f.* Kamrup one tree's height limit).

Riyang.—Tista Valley sal. Plot laid out in 1933. Three focii cleared, and thereafter burned annually, progress of regeneration poor.

No rains weedings were done.

Future treatment.—Pure Kamrup method from now on, an area including the focii to be uniformly treated.

Peshoke.—This plot I have not had an opportunity to visit.

From records it appears wholesale clear felling on a ridge was made and the area burned.

There has been practically no establishment of sal, but it is noted that toon and lampate have come in with miscellaneous coppice.

Here again it would appear that the opening has been too heavy, and weedings and cleanings not done.

In addition to the above a plot was laid out in Apalchand (in a fuel coupe) this year, where the Kamrup method will be applied in its entirety. It is interesting to note that even here in a wet area, previously full of evergreen, where the canopy was interrupted, a few unestablished sal existed.

Mention should also be made of an area in Sivoke. This was burned originally in 1933 with the intention of destroying Hoplo Cerambyx but has been continued experimentally to observe the result in terms of (*a*) bringing in thatch, and (*b*) natural regeneration of sal. It is interesting to note thatch is appearing and evergreen undergrowth is less dense where the burn has been effective, but the burns have been too fierce and damage has occurred to saplings and big trees. There are indications of some sal reproduction though little in extent. Early burning will be done henceforth. A further area in

this block will now be taken upon the Kamrup method by silvicultural division.

From the above, results would appear disappointing, but I would here like to impress the fact that in no plot has the Kamrup method been carried out in its entirety, and we have failed, in my opinion, for the same reasons that the original work in Kamrup failed, namely through not following *in toto* the technique prescribed. In some areas we have not opened the canopy, in others we have not cut back miscellaneous growth and so on, and to these points perhaps may be attributed our failure, and we must continue to give the method of fair chance.

I leave to the last, the thorny point of *Finance.* It is obvious that preparatory fellings, if I may so describe the opening of the canopy, will in certain areas be unsaleable. Cutting back of miscellaneous species and rains weeding will all cost money. We have unfortunately no data of costs to work on, but that the initial cost will be great, is certain—I do not attempt to anticipate a figure—which will be evolved only in the course of time.—(*Proceedings of the Forest Conference held at Darjeeling from 12th to 17th October,* 1936).

NOTE ON THE DACCA-MYMENSINGH FOREST DIVISION

BY Y. S. AHMAD, I.F.S., DEPUTY CONSERVATOR OF FORESTS, BENGAL

1. GENERAL DESCRIPTION

Dacca and Mymensingh are far too well-known as the jute growing districts of India to need any detailed description. They are both situated on the eastern bank of the Jamuna river and with regard to political, educational and revenue matters are the two most important districts of East Bengal. The forest area lies on the high land between the Jamuna and the Brahmaputra rivers, and beyond this are low cultivated land and bils which are inundated in the rains every year.

The area included in the Dacca-Mymensingh Forest Division is situated entirely between the rivers Banar on the east and the

Bangsha on the west, two branches of the Brahmaputra. Both the rivers rise from the Brahmaputra near Jamalpur, north of Mymensingh, and the Banar rejoins the parent stream at the boundary of Dacca and Mymensingh districts, east of Kaoraid, and then flows south through the Dacca district where it is called the Sitalakshya. The Bangsha flows southward in a circuitous course through the whole length of Tangail subdivision in Mymensingh and then through a part of Dacca Sadar subdivision till it falls into the Dhaleswari river. In the extreme north of this tract lies the well-known Madhupur Garh of Joyenshahi forest belonging to the Maharaja of Nattore, its length will be about 15 miles. South of this area starts the Atia forest which extends up to the northern boundary of Dacca district and then to the east lies the Bhowal forest which is mostly in the Dacca district and is about 25 miles in length from north to south. The Madhupur forest has not yet been placed under the management of the Forest Department, but there is a proposal to take it over. The other private forests are: (a) Kagmari, west of the Bangsha river and east of a branch of the Jamuna, called Lowhajung, and its northern boundary is more or less in line with the northern boundary of Atia forest. This belongs to the Maharaja of Santosh and his co-sharers; (b) Alepsingh or commonly known as Rangamati forest, east of the Banar river, starts near the northern limit of Madhupur forest and extends in patches to the northern boundary of Bhowal in the south. It belongs to the Maharaja of Mymensingh and Raja of Muktagacha. Proposals to take over its management by the Forest Department are now with Government; (c) Talipabad, south of Atia forest in Dacca Sadar subdivision between the Bangsha river and the Bhowal forest, belongs to the zamindars of Srifaltali and Baliadi in Dacca.

The district headquarters of Dacca and Mymensingh are connected by a branch line of the Eastern Bengal Railway which runs from Bahadurabad and Jagannathganj on the banks of the Jamuna, through Mymensingh and Dacca districts to Narayanganj on the Sitalakshya river about 10 miles south of Dacca. It passes practically through the whole length of the Bhowal forest.

2. Name and Situation

The Dacca-Mymensingh Forest Division, at present, consists of two distinctly separate tracts, the Atia forest in Mymensingh district on the north and the Bhowal forest in Dacca district on the south.

The area of the Atia forest is 46,183 acres of which 32,226 acres are in Araipara Chakra and the balance 13,957 acres is in Non-Araipara Chakra; the legal distinction is explained later.

The Bhowal forest consists of 381 acres in Mymensingh district and 31,257 acres in Dacca district, in all a total of 31,638 acres. It is bounded on the east by the Banar (or Sitalakshya) river and on the west by the Saldah which is a feeder of the Turag joining the Buriganga river near Dacca. Only 595·79 acres of the Bhowal forest lie on the eastern bank of the Banar river and 807·05 acres on the western bank of the Turag.

3. Configuration of the Ground

The whole forest area consists of highland or knolls, locally called *chalas*, intercepted by numerous narrow depressions or valleys called *baids* which are all cultivated with paddy. The knolls are about 60 feet high above the level of the plains on the average but nowhere do they rise above 100 feet.

The range of ridges generally run from north to south and innumerable small streams run east and west draining this tract to the Banar river on the east and the Bangsha on the west. There is no stream running from east to west across the forest. The country outside the forest slopes towards the south and all the rivers in this locality run from north to south.

In addition to the Banar, Bangsha, Saldah and Turag rivers which form the main arteries for extraction of forest produce by river and for draining the water out, the Goalia river in the south of Atia and the Sera khal and the Chilai in Bhowal are worth mentioning. They all run more or less parallel from north to south, the two latter fall into the Banar or Sitalakshya beyond the forest area on the south and the Goalia falls into the Turag near its confluence with the Saldah,

4. Geology

The soil consists characteristically of yellow-red sandy clay mixed with scattered manganiferous iron ore. The latter is commonly called the Bhowal concrete, and is considered by geologists as particularly suitable for use in primitive furnaces. It is not, however, available in large quantities at one place. The soil is uniformly compact and hard when dry, eroding with the heavy monsoon rainfall where denuded. The newer alluvium is grey in colour. The grey clay soil was analysed at the Forest Research Institute, Dehra Dun, and the result of the analysis was as follows* :—

	Per cent.
Moisture at 100° C	4·97
Loss on ignition	4·34
Clay	31·35
Fine silt	17·65
Silt	25·90
Fine sand	12·58
Sand	1·54
Fine gravel	1·67
Total	100·00

5. *Climate*

The temperature is moderate : April is the hottest month, but the maximum temperature rarely rises above 100° F. The cold weather from November to February is very pleasant, the minimum temperature never falls down to the freezing point and frost is unknown.

The annual rainfall is about 85 inches and is favourably distributed. Mid-June to mid-September is the wettest period. From November to February, the rainfall is less than 2 inches per month, but the climate is cool and damp. March and April are dry.

The prevailing wind comes from the south but nor'westers are quite common from March to May.

* *Vide* page 155, Appendix B, "Regeneration and Management of Sal" by Champion.

6. Legal Position

The area in Atia forest is grouped under two different classes. (*i*) The Araipara Chakra, and (*ii*) the Non-Araipara Chakra. In all the blocks or mauzas in the Araipara Chakra, there are forty proprietors holding the same *proportion of share: thus a zamindar*, holding a two-anna share in one mauza in the Araipara Chakra, holds the same two-anna share in every other mauza in that group or Chakra. But the proprietors of Non-Araipara Chakra hold different shares in different mauzas of that group: thus a zamindar holding only two-anna share in one of the mauzas of Non-Araipara Chakra may hold four-anna share in another and ten-anna share in the third and *so on*.

On the petition of some of the proprietors of Atia forests, in 1923, requesting Government to take over the management of the forests under section 38 of the Indian Forest Act, an enquiry was held and Government in their notification No. 1878 For., dated the 16th February 1925, declared these forests as Protected Forest. The Araipara and the Non-Araipara Chakra forests were mixed up and by *mistake were not differentiated. Dewan Mahim Chandra* Chaudhuri Bahadur, Extra Assistant Conservator of Forests, was appointed Divisional Forest Officer on the 9th October 1925. Soon after, Government wanted to constitute certain areas as Reserved Forest and preliminary notifications were issued and a Forest Settlement Officer was appointed. When the latter commenced his enquiry into the rights an organised opposition was started by the tenants against the forest settlement as it interfered with the unfettered rights they enjoyed under the management of the zamindars. It was also found that two-thirds of the shareholders of many mauzas in Non-Araipara Chakra did not sign the original petition nor agree to the management by the Forest Department. After protracted litigation, long enquiries, continued agitation and the personal intervention of Nawab Bahadur Sir Abdul Karim Ghuznavi, KT., of Dilduar, the then Hon'ble Member, Forests, the Araipara Chakra, consisting of 26 mauzas, was finally declared a Reserved Forest with

a signed agreement with the proprietors and 43 mauzas of the Non-Araipara Chakra in which the Dacca-Nawab Estate holds more than two-thirds shares were also finally declared as Reserved Forest by Government in their notifications Nos. 17115 For., dated the 2nd December 1927, 2813 For., dated the 24th February 1928, 2814 For., dated the 24th February 1928, 2847 For., dated the 25th February 1928, 2841 For., dated the 25th February 1928, 3020 For., dated the 28th February 1928, 8950 For., dated the 27th April 1928, 3361 For., dated the 5th March 1928, 4071 For., dated the 19th March 1928, 7974 For., dated the 2nd April 1928, 8954 For., dated the 27th April 1928, 9122 For., dated the 2nd May 1928, 9271 For., dated the 7th May 1928, 9184 For., dated the 4th May 1928, 9488 For., dated the 11th May 1928, 10046 For., dated the 23rd May 1928, 10402 For., dated the 5th June 1928, 10732 For., dated the 9th June 1928, 10735 For., dated the 9th June 1928, 11008 For., dated the 15th June 1928, 11309 For., dated the 23rd June 1928, 11301 For., dated the 23rd June 1928, 12151 For., dated the 16th July 1928,13404 For., dated the 20th July 1928, and 16870 For., dated the 17th September 1928. The remaining 22 mauzas of the Non-Araipara Chakra were released by Government notifications Nos. 407 For., dated the 3rd April 1934, and 152 For., dated the 11th February 1935, as the proprietors holding over two-thirds shares in them did not agree to the management by the Forest Department. The Bhowal forest which is owned exclusively by the Bhowal Court of Wards was similarly taken over by Government for management by the Forest Department and declared as Protected Forest under notification No. 38 For., dated the 12th January 1934.

According to the terms of the agreement, all expenses for the management of these forests are borne by the proprietors. The expenditure includes 14 per cent. of the pay of the permanent establishment for their leave allowance and pensionary charges. This is deducted from the revenue of the forest for the year and if there is a surplus of revenue over expenditure, Government charge 5 per cent. of that for supervision. After deducting the gross expenditure and supervision charges, the nett profit on the working of the forest

is distributed to the proprietors according to their respective shares. Consequently the expenditure has to be apportioned separately to Araipara Chakra, Non-Araipara Chakra and the Bhowal forests, the revenue obtained from these three parts have to be accounted for separately and also the revenue obtained from each mauza or block of forest in Non-Araipara Chakra has to be recorded separately. If there be any deficit on the year's working, it has to be made good by the proprietors concerned or recovered from the profit of the subsequent years. Government can thus continue to manage these forests till all their dues are recovered.

7. Early History.

Mention of the forests of Dacca-Mymensingh can be traced to the earliest history of India. There is a popular belief that at Gupta-Brindaban in the northern part of Atia forests, the Hindu deities, Krishna and Radha, had their secret romance and even now their admirers visit this place in large numbers every year during the Doljatra in the spring season.

Both in the Hindu and the Muhammadan periods, the Madhupur, Atia and Bhowal forests were the hiding places of many outlaws, of whom the more daring brigands called themselves independent. The Mogul Emperor, Jehangir, during his reign, granted the Atia pargana as a jagir to his physical instructor, Munayem Khan, the first of the Panni family of Karatia, and sent him out to subdue the outlaws. He was the first to hold legal right over the Atia forest and the present proprietors, other than of Karatia family, got their share by purchase or by inheritance by marriage according to the Muhammadan law.

8. Composition of the Forest.

Throughout the whole division, the forest consists generally of pure sal which forms over 95 per cent. of the crop. Patches of scrub jungle and miscellaneous forest are found here and there, especially towards Haritakitala in the south-west and Muraid and Soliabaha in the north of Atia. In the miscellaneous forest ***Phyllanthus emblica***, ***Dillenia pentagyna***, ***Terminalia chebula***, ***Hollarrhena antidysenterica***,

Miliusa velutina, Butea frondosa and Cassia fistula mixed with many other species occur. Miscellaneous forest also occurs towards the south-west of Bhowal.

The purity of sal is attributed to the origin of the present crop from coppice shoots, the weaker coppicing species having been gradually exterminated. Of the few associates of sal, Albizzia procera is the most conspicuous. Terminalia belerica and Dillenia pentagyna also occur and Miliusa velutina and Cassia fistula are found along the edge of the forest. In moist areas and along the banks of streams *Lagerstroemia-flos reginae and Lagerstroenia parviflora* are common. Of the other valuable species, Gmelina arborea and Adina cordifolia occur sporadically. In the north of Atia forest, in one released mauza, Shahar Gobindapur, there is a patch of pure Artocarpus chaplasha.

The second storey is very scanty and consists of the Eugenias, Careya arborea, Randia dumetorum, and Holarrhena antidysenterica which, though common, grows only like a shrub. The blanks and older clearings are covered with Eupatorium and Ageratum.

The most common undergrowth is Pennisetum setosum (Sati) which comes up thickly in the rains throughout the whole forest but dies back in the cold weather.

Sun grass occurs only in the north of Atia forest and to a limited extent in the north of Bhowal. The sun kholas are deteriorating for want of attention. The *baid* or low land, now cultivated, was at one time covered with sun grass, similar to that in Madhupur forest.

Spatholobus roxburghii is the most common climber in the older crop. In young coppice areas, Dioscorea spp., Mucuna pruriens, Smilax, and Ichnocarpus appear frequently.

The quality of sal varies with the locality, on undulating ground with red manganiferous soil, the quality is superior and the proportion of heart-wood is much greater than on flat areas with fresh grey clay soil. In Atia, the quality of sal is better towards the south in Chiteswari and Ajgana mauzas. In Bhowal too the quality is much better towards the south in Chaban, Mitaloo, Bankhuria and other adjacent mauzas.

The size of the sal poles varies usually from 1 foot to 3 feet in girth though trees about 4 feet in girth are also found in better areas. The trees are generally badly misshapen with swollen base due to high cutting in the past, which invariably turns out hollow when felled. The height growth rarely exceeds 50 feet except in good areas where trees up to 70 feet are also found.

9. Silvicultural System.

(a) *Past system.*—Under the management of the proprietors, the forest was leased out mauza by mauza for five years at a time and the lessee was allowed to cut all trees over 1 foot 6 inches in girth at 3 feet height. The result was that not only all trees of that size at the time of the lease were felled, but those that attained the minimum exploitable size during the period of the lease were also removed, and only the suppressed and moribund trees that did not respond to the felling were left uncut. This also explains the present poor condition of the crop and one colossal example may be found in the north-western part of Bhowal in Mawna, and Rathura mauza. Gent, in 1917, found here the best part of the forest with trees with an average girth of 3 feet, but now this area is one of the poorest in Bhowal and hardly any trees exceeding 1 foot in girth can be found there.

The proprietors also insisted on cutting at a height of 2 feet to 3 feet from the ground so that the areas felled over could not be directly brought under cultivation, consequently the present crop consists mostly of trees with swollen, unsound base.

(b) *Present system.*—After the Forest Department took over the management, first of all coppice with standards system was tried but it did not succeed. The standards left were extremely slow to respond to the additional light and space and the coppice regeneration under the standards was also a failure. Since 1934, therefore, simple coppice system with a rotation of 20 years has been adopted. The trees are cut clear and flush with the ground, the coppice shoots that come up in large numbers are very vigorous in their growth at the earlier stage, growing 6 feet to 8 feet in the first year and in eight

years about 25 feet to 30 feet in height and 8 inches to 12 inches in girth when the first thinning becomes saleable as firewood.

In between the clumps of coppice shoots, regeneration from seeds also appears and some experiments have recently been started to devise means to bring this up so that the seedlings can supplement the coppice regeneration.

Every year in March and April the forest is burnt with a ground fire, and this, together with the free grazing which is allowed throughout the forest, probably kills all the young seedlings. The regenerated areas are now closed to grazing for the first three years and also protected from fire.

10. Artificial Regeneration.

In addition to coppice regeneration, the old blanks and the miscellaneous forest will be planted up with sal. Given a clean floor and good seeds, sal germinates in this area like weeds, but to bring it up through the severe drought of March-April is still a problem to be solved. Taungya plantations on experimental scale have been started in various parts, with different field crops and it is hoped that the successful method of raising sal plantation in these forests will soon be found.

There is a good demand for bamboos in this locality and some ***Melocanna bambusoides*** rhizomes have also been planted out this year which so far look very promising.

There are no *jhumias* in this part except some Garos in the north of Atia forest. The local population, mostly Muhammadans, are all engaged in their cultivation in May-June and labour for *taungya* is very difficult to get. The present value of the crop does not also warrant heavy expenditure on wove wire fencing round the plantations to keep out the cattle and the wild pigs.

11. Markets, Marketable Produce and Method of Sale.

Dacca, Mymensingh and the surrounding districts of Sylhet and Tippera on the east, Faridpur on the south, Pabna and Bogra on the west, are all very thickly populated. The village houses are usually

constructed with corrugated iron sheet or thatch roof and bamboo mat wall, so house-posts are an indispensable requisite. Sal poles are ideal for this purpose and the produce from these forests had always a ready sale, the neighbouring districts having no sal forest. The prosperity of the villagers in East Bengal is directly dependent on the jute market and since the slump of 1929, the price of timber has dropped as heavily as that of jute. Even now, the timber can be sold in quantities only after the jute season, from September to November, and the demand for the rest of the year is negligible. The traders come in large numbers, purchase the timber, sling them on the sides of their boats and raft them down to distant markets in their respective districts. Thus Atia supplies house-posts for Bogra, Pabna and the western parts of Mymensingh, Dacca and Faridpur districts. The Bhowal timber goes to the markets on the eastern side of Mymensingh, Dacca and Faridpur districts and is also carried to Sylhet and Tippera districts, further east. The nature of the produce is such that cheap extraction is essentially necessary for profitable business. The timber trade continues as long as the rivers and streams in the surrounding country are navigable and stops when the timber can no longer be rafted about. In this way, in 1935-36, 36,928 sal poles equal to 774,000 cubic feet, were sold from these forests, bringing in a revenue of Rs. 86,000.

The *baids* or low lands which are cultivated with paddy are inextricably mixed up with the *chalas* or knolls containing the forest. The extraction of forest produce to the sale depôts on the river banks has therefore to be completed by the middle of May before the cultivation starts and cannot be commenced till the paddy is harvested towards the end of November. From the areas situated near the rivers, the traders are allowed to cut and log the poles according to their requirement, they also prefer the freshly cut timber to the dry and seasoned one, consequently such forests always fetch higher price. The traders also pay fancy price for larger quantities of heart-wood and the timber from the southern part of the forest is always sold at a higher rate.

Firewood, however, is sold throughout the whole year. From the southern parts of Atia and Bhowal, the firewood is carried in

boatloads to Dacca town and the neighbouring villages, and from the northern part of Bhowal to Mymensingh, throughout the rainy season. In the cold weather, extraction of firewood from Atia stops, but from Bhowal it continues by rail and in 1935-36, 675,000 cubic feet of firewood were extracted giving a revenue of about Rs. 5,000 to the Eastern Bengal Railway in freight. There are also two sugar mills on the banks of the Sitalaksya river, east of Bhowal, and in 1935-36 134,000 cubic feet of firewood were supplied to them in the cold weather. The firewood is cut into billets called *dooms* about 31 inches long and 9 inches minimum girth and sold at Rs. 20 to Rs. 25 per thousand pieces. Two and even four of smaller girths, called *chatties*, are taken as equivalent to one *doom*. An 18-ton wagon can take an average of 4,000 *dooms*. Since 1935-36 a market has been created at Dacca and Mymensingh even for the swollen bits from the base of sal trees, called *mothas*, and for the branches, twigs and chips of bark, from near the railway line in Bhowal. The utilisation in this forest is therefore very intensive. There is no sale of firewood from the northern part of Atia as the cost of extraction is exorbitant. The branches and twigs there are burnt to charcoal in pits, carried to Tangail on pack ponies and sold to the numerous smithies in large quantities. Some saplings, called *rollas*, are also sold in cart-loads in the cold weather at Karatia and other village markets. In 1935-36, 16,000 cubic feet of firewood were sold from these forests for a revenue of Rs. 300.

The silvicultural system being simple coppice, coupes are laid out and demarcated and sold by public auction at lump sum, and the price is usually realised in three instalments. In Bhowal purchasers with big capital have been attracted in fair number, the competition is keen and the prices are reasonable. In Atia, except in the south, capitalists have not yet come forward to purchase the coupes and the prices are still exceptionally low.

12. Administration.

The headquarters of the division, Dacca, is about 20 miles from the southern boundary of Bhowal. It is the second city in Bengal.

Unlike the other divisions, there are no Government quarters for the Divisional Forest Officer. The forest office is also located in a hired house, surrounded by residential quarters in the town, away from the offices of the Collector, the Judge and the other district officers.

There are four ranges in the division, two in Atia and two in Bhowal, and in each unit there is a Ranger and a Deputy Ranger in charge of the ranges. There are three beats in each range with a temporary forester in charge and five to seven forest guards posted to the different parts in the beat. In addition, there is a temporary forester at Dacca and one at Tangail who conduct the forest cases in the Magistracy.

There are a number of toll stations or ghats on the banks of the Banar on the east and the Bangsha and Turag rivers on the west, where transit fees at scheduled rate are realised on all forest produce.

In Atia forest, there are a number of squatters who have been cultivating forest land from a long period but who did not pay any rent to the zamindars. The beat officers, in addition to their ordinary duties, have to realise annual license fee from these people for the reserved forest land which they cultivate. This amounted to Rs. 4,039 in 1935-36.

The method of working the forest is simple, the coupes are sold by auction and the purchasers fell the trees which are sale marked *in situ* after inspecting the stumps to ensure that they are cut properly and good coppice shoots will come.

13. Communication and Buildings.

There are no roads in Atia. There are a few fair weather cart tracks, but the ruts are so deep that it is not possible even to cycle along them in the cold weather. A pony or an elephant can be used or else one has to walk the whole distance. In Bhowal there are several unmetalled district board roads which form the main lines of extraction of timber by carts in the cold weather. The heavy traffic damages them badly every year and only after the annual repairs they become motorable for about four months in the year from January to April. In the rains it is only possible to come to the edge of the forest in country boats and then walk through mud and water across the *baids* to the forest.

There are five rest houses for the Divisional Forest Officer, four at the range headquarters and the fifth in the south-eastern corner of Atia at Kachighata beat. Unfortunately they are like cages, the ceiling and walls having been all constructed with plain iron sheet and four houses have got mud plinth, only about a foot high from the ground and the fifth is a *chang* bungalow with plankfloor about 5 feet high.

In the cold weather, a tent is much more comfortable than any of these houses and in the rains the frogs followed by the snakes always give one the creeps.

14. GAME.

Both Atia and Bhowal were once upon a time full of wild game. Even just over two decades ago, Lord Kitchener, the then Commander-in-Chief in India, came for a tiger shoot in Bhowal with the second Kumar. The old village shikaries say that tigers, leopards, bears, pigs and deer were abundant in these forests and even bison and elephants came down from the Garo Hills in the cold weather. The village shikari and the annual fires have between them exterminated all big game from this area. Some pigs and an occasional deer are all one can now expect to meet. Since the taking over of the management by the Forest Department and protection of the young coppice from fire, the number of leopards is increasing. The Jungle *murgi* and the pea-fowl have definitely increased. A game sanctuary has been started in Bhowal which is vigorously fire protected.

There are several jhils near Atia forest where one can spend a pleasant afternoon shooting duck. The elusive snipe is available throughout the season in the paddy fields adjacent to the forest and provides good sport.

15. GENERAL.

According to the terms of the agreement, the proprietors of Atia are allowed to discuss the budget referring to their part of the forest and send their recommendations for the consideration of Government, provided that proprietors holding two-thirds of the shares in the forest agree to those proposals. The proprietors hold several

conferences in the year which the Divisional Forest Officer has to attend in the capacity of a technical adviser. This contact enables him to convince them of the beneficial effect of the Forest Department management, compared to the management by the proprietors themselves. It was chiefly a matter of *izzat* which caused large areas of forest to be taken out of the control of the Forest Department, but recently there has been a tendency on the part of some proprietors to return to the fold. It is generally admitted that in order to maintain these areas as forest, management on scientific lines by the Forest Department is absolutely necessary. The high overhead charges and the suspicion about their proprietary right in the reserved forest made them dubious. But since the coming in of Bhowal and the prospect of taking over the forests of the Maharaja of Mymensingh and the Raja of Muktagacha, the situation has completely changed and the extra profit, recently, has given the proprietors greater confidence in the Forest Department, the profit in Atia in 1935-36 was Rs. 21,548 against the average of Rs. 8,715 for 11 years from 1925 to 1935 and that in Bhowal was Rs. 51,000 against Rs. 1,253 in 1934-35, and the deficit of Rs. 6,671 in 1933-34. This feeling is to be fostered because the released forests which are inextricably intermixed with the boundaries of the reserved forest are a continual source of worry to the local officers. Also if the whole forest area be under one management the market can be better controlled and the price of forest produce will surely improve.

From the account given above, it will be realised that Dacca-Mymensingh is not a forest officer's paradise. It is essentially a bachelor's division. The society at Dacca and Mymensingh and specially the club at Dacca are ideal. After a month's hard toil in the forest, a week at either of those places is indeed very refreshing. It is a backward division with ample scope for improvement and the manager of the forests can see the progress resulting from his management, from day to day. Surely Bengal does not yet lack in officers who will gladly come forward for their turn at its helm.—(*Proceedings of the Forest Conference held at Darjeeling from the 12th to 17th October 1936.*)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for April, 1937:

IMPORTS

ARTICLES	MONTH OF APRIL					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	..	285	..	..	32,269
French Indo-China ..	..	1,295	533	..	1,28,712	57,823
Burma ..	..	..	14,350	..	..	17,73,792
Other countries ..	..	..	546	..	..	61,628
Total ..	..	1,295	15,714	..	1,28,712	19,25,512
Other than teak—						
Softwoods ..	848	1,283	1,528	54,399	79,635	97,365
Matchwoods ..	..	1,229	1,101	..	70,471	71,442
Unspecified (Value) ..	..	..	..	1,76,255	28,684	2,02,000
Firewood ..	58	39	36	866	555	539
Sandalwood ..	21	8	15	10,868	2,044	1,651
Total value of wood and timber ..	..	..	..	2,42,388	3,10,101	22,98,509
Manufactures of wood and timber—						
Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	331	756	..	66,434	1,69,972
Other manufactures of wood (Value) ..	..	..	..	1,89,579	1,42,756	1,77,716
Total value of manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	1,89,579	2,09,190	3,47,688
Other products of wood and timber—						
Wood pulp (Cwt.) ..	25,558	24,023	16,683	1,76,833	1,49,085	1,08,566

EXPORTS

ARTICLES	MONTH OF APRIL					
	Quantity (Cubic Tons)			Value (Rupees)		
	1935	1936	1937	1935	1936	1937
Wood and Timber						
Teakwood—						
To United Kingdom ..	265	3,618	22	54,843	7,13,667	2,812
,, Germany ..	234	330	..	57,437	77,679	..
,, Iraq ..	38	27	44	8,346	8,145	8,632
,, Ceylon ..	50	188	..	5,500	30,344	..
,, Union of South Africa	..	393	..	..	79,872	..
,, Portuguese East Africa ..	..	224	..	..	34,902	..
,, United States of America ..	..	59	..	..	17,413	..
,, Other countries ..	75	223	50	18,478	46,958	9,705
Total ..	662	5,067	116	1,44,604	10,08,980	21,149
Teak keys (tons) ..	91	331	..	13,650	48,000	..
Hardwoods other than teak ..	..	46	3	.	5,258	840
Unspecified (Value) ..	..	..	..	13,481	21,719	1,67,158
Firewood (tons) ..	15	..	115	250	..	1,027
Total ..	..	..	..	27,381	74,977	1,69,025
Sandalwood—						
To United Kingdom ..	1	1	1	400	600	800
,, Japan ..	2	6	1	2,400	8,000	600
,, United States of America ..	5	50	60	3,650	50,000	58,040
,, Other countries ..	6	13	36	8,515	19,077	37,707
Total ..	14	70	98	14,965	77,677	97,147
Total value of wood and timber ..	..	..	..	1,86,950	11,61,634	2,87,321
Manufactures of wood and timber other than furniture and cabinet-ware ..	..	..	..	8,673	8,739	11,385
Other products of wood and timber ..	No data.			No data.		

INDIAN FORESTER

AUGUST, 1937.

FORESTS AND CLIMATE.

The influence which forests have upon climate has been the subject of investigation for a great many years. Also, it has on numerous occasions been the cause of heated and at times quite unreasoned controversy. As so often happens when there are inadequate scientific data for the settlement of a technical problem people divide themselves into opposite camps taking extreme views and giving vent to dogmatic assertions which cannot be justified by the facts available. The reaction of such extremist statements upon the public mind is most unfortunate, and often in the heat of controversy the main issues become obscured.

The physiological and physical processes attendant upon plant growth reduce the temperature of the air; firstly, because plants transpire water, and secondly, because the sun's heat is absorbed in the process of evaporation. By reason of its composition the living plant substance cannot become heated to the same extent as bare rock or soil. Moreover, the ground under plants cannot become greatly heated by the sun's rays owing to the interception of the latter by the canopy of vegetation. It follows that the effect of forests during the growing season is to lower the temperature of the air in and above them and, by reducing the absorption of heat by the earth's surface, to lower the soil temperature and correspondingly reduce evaporation. Observations have also shown that forests not only moderate the extremes of heat in summer, but that, as a general rule, they also modify the extremes of cold in winter. Keeping in mind the fact that it is at the maximum and minimum extremes of temperature that the more serious damage from heat and cold occurs it is patent that, apart from any benefits which may accrue from forests in other directions, their effects upon the temperature of a region are highly beneficial to man and beast.

By diminishing the velocity of winds forests decrease evaporation and wind erosion. Except in so far as very extensive forests may enrich with moisture the air-currents which pass over and through them, it cannot be said that they exert any great or general effect upon the broad continental air-currents.

Locally, however, forests do exercise a very beneficial effect in ameliorating the severity of winds by virtue of the mechanical obstruction they offer, and the uses made of forests and even of mere patches of woodlands or shelter belts, for the protection of buildings and lands, are universally known.

It is therefore unnecessary to do more than state the fact that the influence of forests in modifying the adverse effect of winds is wholly beneficial.

At various times in different countries, altogether too much credence has been placed in the supposed influence of forests in increasing the total rainfall of a country. No reliable evidence to this effect can be found and I would point out that the topographical features of a country exercise a far greater influence upon precipitation than can be exerted by forest alone. On the other hand, there is evidence to show that forests have some influence upon the local distribution of rainfall, by lowering the temperature of moisture-laden winds, and in other ways, and that from this viewpoint a judicious distribution of forests throughout a country is highly beneficial.

Under a leafy canopy, the humidity of the air is higher in the forest than in the open. The process of transpiration of itself increases the moisture content of the air within and near the forest; also the temperature of the air within the forest is lower, and consequently nearer the saturation point. Under the influence of these two factors, manifestly the influence of forests is to increase relative humidity.

Experiments extending over a great many years have demonstrated that the evaporation from soils within the forest is less than in the open. The greater the wind, the higher the temperature, and the lower the relative humidity, the greater must be the evaporation

from the soil; consequently, the forest, by reducing the velocity of winds at the surface, by reducing the temperature, and by increasing humidity, necessarily retards evaporation.

Climate, being a combination of all the above factors, has without doubt seriously deteriorated over large portions of the earth by reason of the destruction of the forest. While afforestation may have only a slight bearing on the climatic conditions of a country, the progressive destruction and degradation of vast areas of natural forest result in increasing aridity, the desiccation of the soil and the impoverishment of mankind.

It has often been either stated or implied that the absolute climatic factors, temperature, wind and rainfall, are the result of solar and terrestrial conditions which man cannot alter. It is a fact, however, that by exercising judicious control of the vegetative cover, man can modify the effect of climatic factors and so lessen appreciably the detrimental results to which those factors may give rise.

The decay of Persia, Asia Minor and Central Asia can largely be traced to the destruction of the forests on the mountains. Disastrous results from disforestation in India are only too evident in Hoshiarpur, Kangra, Jammu and Chota Nagpur.

II—Forests and Water Conservation.

Apart from their utility in the supplying of wood products, some of the most beneficial effects of forests lie in their influence in conserving the supply of water for natural springs and reservoirs, and in regulating the flow of streams and rivers. In very few parts of the world is there a reasonably uniform distribution of rainfall. Practically all countries experience definite seasons when precipitation is heavier than at other times. Water being one of the things most vital to animal and vegetable life the effort of man from time immemorial has been to conserve it and put it to use in such places and at such times as his cultural and industrial pursuits have demanded. It is a sad commentary upon man's efforts in this direction that the earlier civilizations started their conservation works at the wrong

end. One of the reasons for the decay of the great irrigation works of Iraq, the ruins of which far surpass any similar undertakings of to-day, was the neglect or inability to control the catchment areas of the Tigris and Euphrates. The control of water supplies must follow natural laws, and it is only in comparatively recent times that this fundamental fact has been realised ; even now the attention given to the conservation of catchment areas is wholly inadequate.

It has been held that engineering works constitute the proper means for the regulation of water-supply. This is true only to a certain extent. Engineering works cannot take the place of nature, rather they should be used to supplement and augment her provisions.

It is easily demonstrable that forests play a highly important role in the conservation of water and regulation of its flow. Almost every forester can recall a woodland spring that upon removal or serious disturbance of the forest dried up, and the majority of people can cite instances of the partial or total drying up of water-courses, resulting from the same cause.

It is impossible to divorce water conservation from climate. The first influence of the destruction of the forests is on the moisture content of the land, the diminution of perennial streams, the increase of floods, the deposit of detritus by wind or water, and the gradual reduction of cultivation. All this is followed by increasing aridity, by the greater desiccating effect of wind, by increasing severity of climate, until the land will no longer support a wealthy and prosperous population. Poverty grows with the deterioration of the land until the time arrives when man departs leaving a desert behind him.

Many Indian rivers previously navigable by ocean-going sailing ships can now only be navigated by canoes or similar craft. This deterioration is due to the silting of their channels by eroded material from the hills.

The question of silting in reservoirs has been causing the greatest anxiety to engineers ; the rapidity of silting on denuded catchment areas has often exceeded the professional estimates and has rendered many of these undertakings entirely unprofitable. Irrigation

engineers in India are apprehensive on account of the decreasing winter supplies of water and of the increasing number and severity of floods. It has also been proved that silt-laden water does not penetrate into the soil and therefore largely runs to waste. There is overwhelming evidence that forests have a regulating effect on stream flow, decreasing floods and increasing the flow of water at dry times of the year when streams from a disforested area dry up altogether.

In general it may be accepted that forests use up a certain amount of soil moisture and, in areas of low rainfall, may exercise draining influence on the soil. Some eucalypts have a pronounced action in this respect and have been used for the draining of swamps. There is no reliable information as to how deep this action goes, but it is unlikely that it goes much below the depth to which the mass of the feeding roots penetrate, that is,to a few feet at most. There is no reliable evidence to show that the sub-soil water level is lowered by planting trees or that they have any effect on deep-seated springs or on the water table ; their action appears to be confined to water on or near the surface, much of which would in any case run to waste on a denuded catchment area.

Researches by Burger and others show that forests allow rain to penetrate into the soil, thereby feeding deep-seated springs. This penetration is due to the fact that forest soil, mainly owing to the action of tree roots which ramify through it, is far more porous than soil of identical origin in the open. The presence of a layer of spongy humus or a mass of needles and undecomposed vegetable matter also contributes to the absorption of water and the prevention of run-off, but it is now recognised that the absorptive capacity of humus is of less importance than that of the forest soil itself.

The draining effect of forest is most pronounced on level ground where swamps tend to form. On hillsides any action which may be considered deleterious to water conservation is far more than counterbalanced by the beneficial action of forests in mechanically obstructing the run-off and increasing the porosity of the soil.

III—EROSION

It is unnecessary to recapitulate all that has been stated on this aspect of the subject. It is admitted by all authorities on erosion that one of the greatest calamities which have overtaken mankind has been the destruction of the forest and the consequent erosion of the land surface. This has already destroyed the fertility of many lands and is at the present day exercising a powerful influence on the destiny of peoples.

Erosion results from the misuse of the surface covering of the earth, whether it be by the destruction of the forest which covered it, by the misuse of arable or pasture land, by bad methods of cultivation, by burning or by overgrazing. Erosion is worse in countries of low rainfall and hot summers than where an ample rainfall covers immediately any bare surface with vegetation. The conflagrations which rage throughout the savannah forests gradually end in their destruction. The heat of the sun, hot winds and the trampling of stock pulverise the surface soil, which is then blown away by the wind or washed by the torrential downpours which generally follow prolonged periods of drought. In this way the whole top soil may gradually be eroded away in the form of sheet-erosion, leaving an infertile sub-soil from which man can at the best eke out a miserable existence. Thus the destruction of the savannah forest leads imperceptibly to the desert which can support neither man nor beast.

The geological formation exercises a powerful influence on the rapidity of erosion. Once denuded of their natural covering, land such as the tertiary formations of the outer Himalaya are eroded with appalling rapidity. There is evidence, however, from all over the world that even where erosion, especially sheet-erosion, has actually commenced, it is possible to remedy the position by preserving the natural vegetation and by afforestation.

Where extensive gullying is already present, afforestation must be combined with engineering operations of a minor nature, such as the construction of small damp fascines, etc. The combination of such engineering operations with the protection of the soil from

burning and grazing, together with afforestation, can deal with the problem.

Enough has been said to point out the beneficial effect of the forest as a natural cover of the surface of the earth and of the disastrous results of the destruction of such cover. Whether it be on the mountains of the Himalayas, the high-lands of Australia, the savannah forest of Africa or the plains of North America, wind and water, unrestrained, exercise their powers of disintegration on the denuded surface of the earth, ruining land laboriously prepared for the satisfaction of the needs of mankind and rendering once fertile areas sterile and uninhabitable.

IV—Conclusions.

It has been endeavoured in this short talk to deal briefly with the subject of the influence of forests on climate, water conservation and erosion, and to point out the evils resulting from the destruction of the natural cover of the surface of the earth and the misfortunes which have arisen from such destruction.

These are very much graver than the ordinary person realises. It has been my unfortunate lot for many years to take the part of a prophet preaching evil things to a sinful world and it is notorious that prophets are exceedingly disliked. Generally speaking it must be admitted that prophets have prophesied what has come true but that can be of little comfort to them. Only very recently you have read of the appalling floods in the Ohio and Missisippi rivers, of the duststorms in the prairie provinces of America, all of which disasters are largely due to the destruction of the forest and these terrible events should surely warn you to take care that the existing forest area of India should be carefully preserved and that where the face of the earth has been ruined whether on the outer hills of the Himalayas, the plateau of Chota Nagpur or the hills of Southern India, steps be taken to mitigate this ruin and to restore the forest cover which once clothed them.

I wish you all good night.

NOTE.—A broadcast talk given by Sir Gerald Trevor, Inspector-General of Forests, from the All-India Radio, Delhi.

THE SHELTERWOOD COPPICE SYSTEM

BY W. T. HALL, I. F. S.

Summary.—The system of shelterwood coppice for *sal* is described and modifications in management under this system are suggested.

Application.—This system is in force over about 30,000 acres (stocked) of sal forest in the Pilibhit forest division, U. P. It was originated by Trevor when Conservator of the Working Plans circle and first introduced in Hall's Pilibhit working plan of 1923. A short description of the system is given in " Practical Forest Management " (Trevor and Smythies, 1923) which is now out of print.

I believe the system could be introduced with advantage in other parts of the United Provinces with modifications to suit local conditions. The system would also be applicable to species other than sal, where regeneration can be obtained mainly from coppice and where it is essential to protect the young crop from frost during a part only of the rotation.

For these reasons it was considered worth while bringing it to the notice of a wider circle of forest officers, to describe management under this system in greater detail and to discuss such modifications in the management as are indicated by our experience of it during the last 13 years.

General treatment indicated in Pilibhit.—The general treatment considered advisable in these forests in 1923 was indicated by the following factors :

(1) The results of past management, the market and the condition of the crop indicated that regeneration mainly from coppice would be the quickest, safest and best means of regenerating the forest.

It was never contended that the entire area of the forest allotted to this working circle was suited to the immediate application of the system. In forests such as these, conditions are so variable over even small areas that it is impossible to legislate for every varying condition under any system of management.

(2) Frost occurs almost annually and is severe enough to make protection for the young coppice essential for several years. A system of simple coppice as adopted for *sal* in Gorakhpur is out of the question. But frost is generally not severe enough to make protection necessary when the coppice is about 20 feet high.

The silvicultural system.—The initial operation is similar to that under a system of coppice with standards. Each felling series is divided into equal (if possible equi-productive) annual coupes by area according to the number of years in the rotation. 30—60 standards are marked for retention according to the size of the standards, and everything else is felled to 6 inches from ground level. (An exception should now be made in the case of *rohni*, which is very prevalent in Pilibhit and which should be felled at breast height in the main felling to minimise suppression of the sal coppice.) Nothing is retained as part of the future crop. Contractors are bound by their contract to fell everything no matter what its size, except the reserved standards. The year after the main felling a cleaning is made in the one year old coppice. When the coppice is five years old, the standards are reduced to half (except where the coppice has failed) and the coppice is thinned and cleaned. When the coppice is 10 years old the standards are finally removed. The latter prescription was much too rigid and the marking officer now has the power to retain them in part or in whole for a longer period where the coppice has failed, where it is backward or where unusually severe frost damage is to be feared. At the same time a second thinning is made in the coppice but from then on thinnings are done on a 10-year cycle. Cleanings are repeated after each thinning.

Factors for success.—The system depends for its success and permanency on the following factors:

(1) A sufficiency of young coppiceable stems (*i.e.* particularly stems up to 10 inches diameter).

(2) The presence of suppressed advance growth of seedling origin, which when cut back will give vigorous coppice (now usually referred to as *seedling* coppice).

(3) Protection from repeated severe damage by frost, browsing and fires.

(4) Thorough cleaning operations repeated annually where necessary for several years.

The Standards—Number.—The best number of standards to retain must vary with the amount of protection from frost required in each locality and with the size of the standards retained. I am of opinion that it is nowhere safe in Pilibhit to have less than 40 standards per acre during the first five years of the coppice when the average diameter of the standards is 12 inches or less. Experience has shown that except in areas of exceptional growth 50 standards per acre *of this average size* have no detrimental effect on the growth of the coppice for the first five years. But when the average size of the standards is above 14 inches diameter, even 40 standards per acre may suppress the coppice and be more than enough to provide adequate protection against frost. The working plan should therefore indicate the number to be left with various sizes of standards. Generally speaking, enough overhead protection will be provided with ½ complete canopy, and the following table based on that given on page 76 of the 1923 Pilibhit Working Plan indicates the number of standards which should ordinarily be retained in a third quality sal crop :

Average diameter of standards.	*Initial number of standards per acre.*
8 inches	90—100
10 ,,	60—70
12 ,,	40—50
14 ,,	30—40

The importance of the correct number of standards to retain is evident in several of the Pilibhit coupes. Too many standards have sometimes been retained. Within the limits suggested above the higher number should be retained where frost damage is likely to be most severe. Such places can often be foreseen before the main felling is carried out.

Class of standards.—The standards should be of sal with clean boles and good crowns. Even spacing should be considered as far as possible, but the choice of the best trees as standards should not be sacrificed for correct spacing within reasonable limits. The working plan might have indicated the diameter class of tree to be preferred as a standard, but this will vary in each coupe to some extent. Where there is a choice, mature trees should not be chosen and I would personally prefer to keep trees of the 12—15 inches class which have not suffered from suppression and are capable of benefiting from the light increment during the 10 years or more before they are felled. At the first thinning the less thrifty standards should be removed first.

Cleanings.—Cleanings are prescribed in the year after felling and again after the thinnings. These include the following operations:

(1) Cutting back standards broken in the fellings.

(2) Cutting all miscellaneous species interfering with sal. Such species will be retained in blanks.

(3) Coppicing back of all damaged and faulty shoots. In the first cleaning this will not be necessary unless a dominant stem has been formed, and after the first and second thinning only when the stem has adequate room to develop.

(4) Climber-cutting.

(5) Coppicing back sal advance growth of seedling origin which has reached a woody condition.

Both the 1923 and 1932 working plans prescribed only one cleaning operation after the main fellings. This was a pity and partly accounts for the inadequate cleaning operations being carried out. From what I have observed in recent inspection the working plan should have prescribed the cleanings for two years after the main felling and *whenever considered necessary,* as well as after each thinning. All coupes want cleanings again in the second year if for no other reason than the coppicing back of shoots damaged by deer. This second cleaning is often more important than the first. Many coupes urgently require a further cleaning in the third or fourth year where suppression or climbers are particularly bad.

The 1932 plan states that when cutting back miscellaneous species " it must be remembered that it is desirable to encourage light crowned miscellaneous species up to about 20 per cent. of the final crop ." If this advice were practised to the full, it would lose us one-fifth to one-tenth of our future revenue—a high cost to pay for an unproven theory. Actually the miscellaneous species come up without encouragement and are not cut back in blanks where there is an absence of sal. However advisable it may be in high forest, it is not necessary and may be highly dangerous to encourage such species in a coppice system of management. I prefer the prescription in Drummond's Gorakhpur Plan of 1934 : " In coppice the cleanings must be very drastic as regards the removal of inferior species, as their growth is so much quicker than that of sal. Every stem of miscellaneous species must be cut back except in patches where there is a complete absence of sal. "

The importance of adequate cleaning operations under this system of management cannot be over-emphasised. It is recognised that there are not sufficient coppiceable sal stems in many areas to give normal density and this is all the more reason why the greatest care should be taken to give the coppice shoots every attention during the vital period of the first five years.

Thinnings in coppice.— The first thinning in the coppice is prescribed for the sixth year and it would generally be sufficient to treat this as a purely mechanical operation under a forest guard, reducing stems to one per stool. The second thinning is done in the eleventh year and in good quality areas the coppice may have an average height of 35—40 feet. This must be a real thinning. Thereafter it is prescribed that thinnings will be on a ten-year cycle, but I would now prefer to do a third thinning in the fifteenth year before starting the ten-year cycle.

Thinnings in standards.— In the sixth year the first thinning in the standards is carried out and it is of the greatest importance to remove the unthrifty standards first, and to leave the best trees capable of benefiting from the light increment. The question of spacing is less important at this stage than at the time of the main felling

although it must still be considered. In the eleventh year all standards are removed unless their retention is necessary for reasons already given. There is a tendency to leave standards in tiny so-called blanks and it would probably be better to make a rigid prescription that standards will not be retained in a blank of less than one-tenth of an acre unless there are other reasons for retention.

Rotation.—In the case of sal the system can be applied to any normal coppice rotation or to the longer rotations usually adopted for high forest systems. For sal coppice we have statistical data for crops up to 70 years which tend to show that we can grow crops from stem coppice origin on the usual high forest rotation. The rotation adopted by the 1923 plan was 60 years, raised by the 1932 plan to 90 years.

Preparatory fellings.—In the 1923 plan "a heavier thinning in the nature of a preparatory seeding felling" was prescribed in the tenth year before the main felling to encourage the growth of a new seedling crop. These have been described as a failure and have been given up. In their place have been substituted selection fellings in unallotted areas, under which 33 per cent. of trees over 19 inches diameter are felled. In effect this opens up the canopy to about the same extent as was intended under the preparatory fellings rather vaguely prescribed by the 1923 plan but with the great advantage that it prevents the over-felling which took place under the excuse of the preparatory fellings after 1924.

A period of 10 years is, under our present knowledge, too short in which to produce seedlings capable of giving coppice shoots when cut back, even if a good deal of regeneration up to 12 inches high already exists on the ground as was the case in 1923. But in the Pilibhit coupes in which preparatory fellings were done and in the ordinary main coupes, I have been very much struck with the seedling regeneration which now often exists in the whippy stage up to 33 feet high.

Effect of browsing on management.—Smythies has shown that protection against deer is an essential factor for success in natural sal regeneration from the whippy stage wherever deer are common. It is even more important where regeneration is obtained chiefly from

coppice. It is true that under any system of complete or partial clear-felling by successive annual contiguous coupes, the amount of food offered may be more than the deer can consume and for this reason a certain percentage of success may be assured. But there are instances where browsing has caused enormous permanent damage, particularly when associated with the other factors of frost, fire and suppression. There is scarcely a coupe in Pilibhit which has not been permanently affected to some extent by browsing, forcing us often to accept as the future crop stems which are most undesirable, affecting seriously our future revenue.

Under this system of management I am prepared to give each coupe a second chance in the gamble against deer but thereafter we should be prepared to erect deer-proof fences wherever necessary. I think I am right in saying that in Pilibhit not a single coppice coupe has been protected by a deer-proof fence. I am not concerned in this note with the wider financial aspect of the problem which faces an administrative officer, but I am prepared to say that from a purely silvicultural point of view we have not been putting back into these forests anything like the amount of money we should have done by greater expenditure on cultural operations and deer-proof fences. We have scarcely the right to continue taking the revenue from further main fellings until we are granted adequate funds to tend the coupes we have already felled. This division has benefited enormously in revenue and surplus to a large extent by the adoption of this form of management, so from a purely financial point of view we have a good case for greater expenditure. The following figures speak for themselves :

Period.	*Average annual revenue.*	*Average annual expenditure.*	*Average annual surplus.*
	Rs.	Rs.	Rs.
1921-22 ..	51,172	67,988	—16,816
1923-31 ..	2,48,867	89,122	+1,59,745
1934-37 ..	2,10,448	75,359	+1,31,722

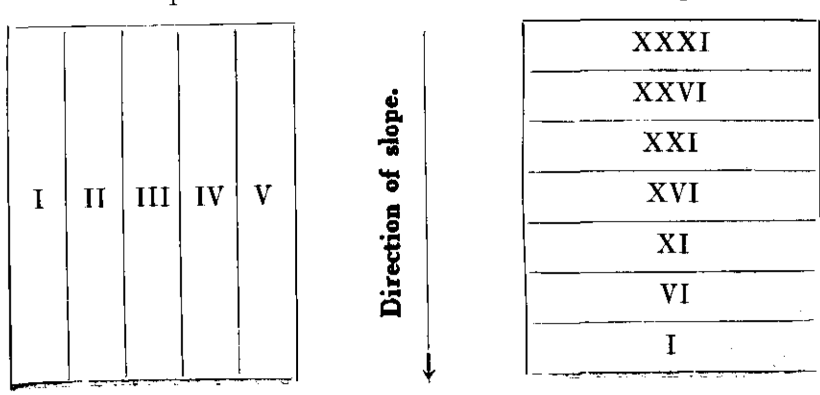
Effect of frost on management.—During the last 10 years or so frost has more and more become a major problem of forest management

in our U. P. sal forests. From what I have seen in this division as well as in Gorakhpur, where systems of clear felling are in force, we shall have to consider in future working plans the direction of felling, the size of the annual coupes, and the creation of cutting sections.

Direction of felling.—These systems of clear felling are, I consider, creating conditions favourable to frost. What is often happening, both in Pilibhit and in Gorakhpur, is that cold air collects, flows down even a gentle slope until it comes up against a wall of unfelled forest, and is banked up. At Nawadia, in Pilibhit division, one can see the coppice on the slightly higher ground in the north completely free of frost damage. As one goes lower, frost begins to appear but only side branches are at first affected, getting higher and higher until we find coppice up to 40 feet high killed back by the exceptionally severe frost of 1935. (At Nawadia there is an additional factor of a slight depression in which it is possible nothing would have saved the coppice from as severe a frost as in 1935.) In this locality the coupes were laid out in narrow strips more or less north to south and in the direction of the slope. It would have been better if these coupes had run east to west across the slope and if the order of felling the coupes had been from south to north, *i.e.*, starting at the foot of the slope first. The following sketch illustrates the point:

Fig. A. Wrong arrangement of coupes.

Fig. B. Correct arrangement of coupes.



In Fig. A, the coupes are arranged in strips running in the direction of the slope.

In Fig. B, the coupes run across the slope and felling proceeds from the foot of the slope upwards. They are also numbered as they would be if the age gradations were divided into five cutting sections so that fellings are not done in adjoining coupes until after a period of five years.

Size of the annual coupes.—In Gorakhpur and in Pilibhit the annual coupes are as big as 166 acres and 147 acres respectively. There is nothing in the management of these divisions which makes the creation of such large coupes necessary and they make protection against all kinds of danger more difficult. The remedy is the creation of more felling series with smaller annual coupes in each.

Cutting sections.—Both in Gorakhpur and in Pilibhit, fellings are in successive and contiguous coupes. This again makes protection from frost and fire more difficult, and such an arrangement is not necessary for management. In both divisions there is evidence that protection against frost is provided by adjoining forest and an arrangement of coupes in cutting sections would help to prevent the flow of cold air already referred to. In Pilibhit particularly, fires have caused considerable damage to the young coppice crop and such damage would be greatly minimised by having cutting sections. The ideal would probably be for coupes to be arranged in strips and that fellings would not be done in an adjoining coupe until a period of five years had elapsed. This would now be exceedingly difficult to adopt without considerable loss in areas already felled, but this would be a problem for the future. Felling series with three to five cutting sections could easily be formed now from unallotted areas.

There is one form of damage against which an arrangement of more felling series with cutting sections would probably not by itself be beneficial, and that is damage by deer. It would, however, make protection against deer by deer-proof fences simpler and more efficient. We have already learnt by experience that it is impossible to protect large self-contained areas by fences but by having scattered coupes

of not more than, say, 75 acres each, in which protection would no longer be necessary before the adjoining coupe was felled, protection against deer could be made as efficient as is necessary.

Modification for seedling regeneration.—As already noted all the forests allotted to this working circle are not entirely suited to the system, but where there is a deficiency of coppiceable stems there is often a sufficiency of seedling regeneration in the whippy stage, 2 to 3 feet high. Where this is the case, there is nothing in the system to prevent adoption of the latest technique to bring such whippy regeneration to the established stage. The main felling and first thinning in the standards will reduce the canopy to permit sufficient overhead light. That part of the coupe deficient in stem coppice will require fencing against deer, and shrub-cutting in the rains, or at least in the cold weather, will have to be resorted to for a number of years till the whippy regeneration becomes established.

Nomenclature.—No satisfactory short title was originally given to the system which I have tried to describe. In the 1923 working plan we called it "High forest with regeneration from coppice and seed." The 1932 plan called it " High forest regenerated with coppice " and further defined this by calling it a system of " clear felling with frost protecting overwood and regeneration from coppice." Trevor refers to it in his new book on Silvicultural Systems as " Shelterwood Coppice " and as an alternative title I would suggest " Coppice with Reserves."

The name is of no great importance but in India and in Europe the main basis of classification of silvicultural systems is (*i*) ***High Forest Systems***, where the regeneration is mainly of seedling origin and (*ii*) ***Coppice Systems***, where regeneration is mainly from coppice. For this reason I prefer not to use both terms in the title as was formerly done. But the matter is complicated by the fact that " High forest " is further defined as a system *where the rotation is long*, and with sal we can and do regenerate mainly from stem coppice and yet have a long rotation.

REGENERATION AND PROPAGATION OF SANDALWOOD

BY RAO SAHIB S. RANGASWAMI, RESEARCH RANGER,

DENKANIKOTA, SALEM NORTH DIVISION, MADRAS

Summary.—Natural reproduction of sandal, general seasons of seeding and the seeding capacity have been discussed.

The causes for the absence of seedling growth in certain localities have been traced to seed destruction by various agencies especially rodents.

Natural spread of sandal in Salem North Division since 1869 has been worked out. The importance of seed selection by natural agencies such as birds, animals, etc., pointed out. Various artificial methods of sandal propagation have also been described and the merits of artificial regeneration from nursery-grown plants by different methods over direct sowings have been indicated.

INTRODUCTION

In silvicultural practice the regeneration and propagation of any species is regulated by the question of cost and also by the return of the crop. The extent of nursing, tending and protection of the forest crop naturally depends upon the value of the crop. In the case of agricultural crops, the yields are intensive and quick, and also the return per acre is usually more than any forest crop known. Forest crops on the other hand take a long time to mature and the cost of nursing and protection naturally is very high. Sandal is the most valuable crop among forest trees and the question of its propagation is here dealt with under two heads, *viz*:

(A) Natural Reproduction, and

(B) Artificial Reproduction.

(A) NATURAL REPRODUCTION

(*i*) *Seeding.*

Sandal is a prolific seed-bearer and its ordinary and general fruiting seasons extend from June to September and again between November and February. Further it is easy to find at one and the same time trees laden with flowers and fruits or rather in all stages of reproductive activity scattered about in sandal areas.

It reproduces itself plentifully from seed and also to a certain extent by root-suckers and coppicing.

(ii) Absence of seedling growth in many places and the causes of such absence.

The general absence of seedling growth in some natural sandal tracts is due to various causes both before and after germination. In certain reserves, *e.g.*, Noganur, I have seen the ground below parent trees carpeted with seedlings but subsequently not even 1 per cent. were found alive. In other reserved forests, *e.g.*, Denkanikota R.F., even though the ground below sandal trees is covered with seeds, we do not find many seedlings afterwards. The destruction of seeds and seedlings has been actually calculated in various areas and dealt with elsewhere in this report.

The chief causes for such destruction are:

(*a*) Attack by rodents.
(*b*) Fires.
(*c*) Trampling and browsing by cattle and wild animals.
(*d*) Rotting of seeds, due to exposure to excessive sun and rain.
(*e*) Excessive weed growth and smothering of seedlings.
(*f*) Drip and dampness.

In areas where there is a good amount of sandal enough seedlings to restock the areas survive but in areas where sandal is sparsely distributed, artificial aid is necessary. Experiments have been carried out in this direction.

(iii) Artificial production and establishment of natural seedlings.

Parent trees have been selected and when the seedfall is about to take place or has just taken place, the undergrowth to the extent of the width of the crown of the parent trees has been cut back, the ground raked up and all fallen seeds pressed into the soil. The cut stuff is again put back to prevent browsing of seedlings on germination. The seeds germinate within three months and when the seedlings are about three months old, the thorns put above them are removed and used as fencing in places where grazing is intense. By this time, the stumps of the undergrowth also shoot up and act as hosts to the germinated seedlings.

Within a year the seedlings grow to a height of 2 to 3 feet. By this method natural regeneration has been well established in one of the experimental areas. This work has been carried out in both the fruiting seasons year after year since 1929, and to keep up the age classes, separately, regrowth of seedlings in subsequent years has been removed year after year. (See Plate No. 35.) This has been carried out in a dry locality like Bangalore. If the work is to be repeated in Coorg, where there is a heavy rainfall, constant weeding would be necessary. The important operation here is the constant thinning of sandal plants leaving only the best in proportion to the amount of hosts available. The excess plants removed are being used for stumps in other areas.

(*iv*) *Effect of shifting cultivation on natural regeneration of sandal.*

In 1926, I inspected the Kollimalais and Pachamalais, where there had been shifting cultivation some time previously. The regeneration of sandal was plentiful and the bushes of coppice regrowth from trees and shrubs felled when the land was brought under cultivation were protecting the seedlings from getting browsed or otherwise damaged.

Some big plants were also seen which I think were root-suckers obtained from lateral sandal roots injured during the process of tillage. As the stocking of sandal was poor, perhaps 50 to 100 per acre, and as the locality and soil factors were good, the seedlings should have been getting enough nourishment from the young and vigorous roots of coppice growth.

Mr. M. Rama Rao's observations more or less coincide with the above and he states that on the Javadis, sandal generally exists "not in the virgin forests of which we have still a few small remnants here and there, not in the luxuriant evergreen sholas which grace the highest peaks, not in the heart of massive forest blocks away from human habitations; we do not even find it on forest land in the proximity of such habitations unless it has been tilled once by the hand of man. In fact it is only found on lands cleared, cultivated and then abandoned to relapse into their primitive sylvan state."

Fig. No. I.
SANDAL GROUP REGENERATION UNDER MOTHER TREE. NOGANUR R.F. SALEM NORTH DIVISION

Fig. No. II.
SHOWING THE SANDAL STUMP AND SANDAL STUMP REGENERATION

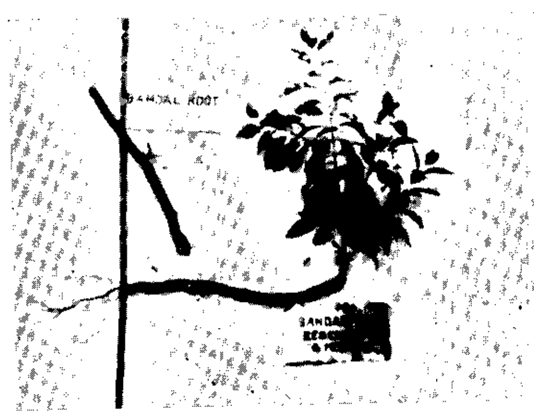


Fig. No. III.
SHOWING SANDAL ROOT READY FOR PLANTING AND SANDAL ROOT REGENERATED. NOTE THE HEIGHT OF SHOOTS WITHIN 4 MONTHS

(v) *Types where natural regeneration is plentiful.*

Sandal trees are found in appreciable numbers on the following classes of lands :

(a) Lands now under cultivation. On such they are few and scattered.

(b) Hedges of cultivated lands.

(c) Old fields abandoned comparatively recently and on which young scrub has come up.

(d) On forest lands subjected to shifting cultivation for two or three years and then left to reclothe themselves with vegetation. We have such lands of all ages, and it is on the older of them that we find abundance of sandal trees in all stages of growth. These comprise the largest and the best sandal areas on the Javadis and Yelagiris.

(e) Narrow belts of forest reserve hardly exceeding a furlong in width and bordering on the above four classes of lands. Such belts are sparsely stocked with sandal which must have spread from the cultivated lands very slowly and gradually.

In the interior of dense forests, whether evergreen or deciduous or even scrub, little or no sandal is found. Where isolated patches of it exist in such localities, those patches were once the sites of deserted villages or abandoned cultivation.

Such, for instance, are the sandal patches of Mundapatti and Settipatti on the Javadis. From the articles and reports of Messrs. Pigot, McCarthy, Ricketts, Colonel Walker, P. M. Lushington and others that have appeared from time to time in the *Indian Forester* and elsewhere, it is to be gathered that in all provinces and districts in which it is found, natural growth of sandal is confined mainly if not entirely to the same descriptions of lands as those on which it is found on the Javadis and Yelagiris.

(vi) *Reasons for the presence or absence of profuse regeneration.*

The foregoing remarks naturally suggest the following two questions :

(I) Why does not sandal occur in dense forests high or low ?

(II) Why does it confine itself to lands once under cultivation or to their immediate neighbourhood ?

(I) In natural dense forests, the leaf canopy being complete (1) sandal seeds and seedlings are deprived of the free circulation of air and sunlight which are essential for the germination and growth of the seedlings; (2) the soil being covered with a more or less thick layer of decaying leaves and twigs is moist and cold, and consequently seedlings damp off and die; (3) such of the seedlings as survive are suppressed by the overhead cover; (4) there being generally an absence of undergrowth in canopied forests the seedlings are exposed to trampling and browsing by cattle and wild animals; (5) when seedlings survive the above causes, they are destroyed by fires; (6) it is also probable that the absence of an adequate and suitable undergrowth deprives the young sandal of the chance of forming sufficient root connections with other species and thereby acquiring the requisite vigour and power for it to hold its own in the struggle for existence.

In the interior of open forests also, sandal is absent, because firstly, the soil being hard, dry and impervious by exposure to sun and rain and the constant tread of cattle, does not give a suitable lodgment for the seed; secondly, the delicate seedlings that may come up succumb to the influence of the tropical sun; thirdly, the occurrence of fires in such forests is frequent and destructive owing to the dense growth of grass and other rank vegetation; fourthly, the hardness of the soil retards and checks the rapid development of its root system and consequently the formation of adequate root attachments with other species.

Seed dissemination by birds, animals, etc.

As also in the case of other species, there is always seed dissemination helped by natural agencies. With certain species of plants, the natural distribution is helped by providing the seeds with a winged structure which enables the seed to be carried over long distances by wind. In other cases, the opening of the fruit is so devised that the seeds contained in it are split off with considerable force so that the seeds are scattered mechanically over a large area. In yet other instances the seeds are provided with a fleshy pulp which is edible and which is therefore eaten by animals. In such cases, the seed coat is

a hard shell which resists the action of the juices of the alimentary canal. When the animal or bird swallows the seeds for the sake of the fleshy pulp the animal or bird is able to distribute the seeds over a long distance through its excreta.

In the case of sandal, this type of natural distribution is limited. A number of excreta of birds, wild cats, and other animals have been examined and a quantity of seeds have been obtained. It is also on record that certain species of birds devour these seeds and excrete them. In all these cases the result is the distribution of sandal to limited areas.

Copious regeneration of sandal around mother trees is not very desirable since the multiplication of parasites in the same area is not desirable. The dissemination of the species through other agencies is certainly one of the best means that is available for the natural distribution of sandal.

Selection of seed by animals and birds.

There is one more point which is to be made very clear and that is the selection of the sandal seeds which the animal probably makes in the course of its feeding. It is well known in the case of certain fruits that the parrot has an infallible instinct for selecting the best fruits and it is the popular belief that a fruit which is injured by a bird in the course of its feeding is the most delicious and the most nutritious. In other words, birds are capable of selecting the best fruits and this circumstance ensures the regeneration and distribution of only such of these seeds which are the best. As a corollary to this observation it may be mentioned that the natural regeneration that takes place through the agency of birds and animals gives rise to plants which are good in every respect not only with regard to their vigour of growth, their resistance to disease but also, perhaps, in regard to heartwood formation.

To what extent this mode of propagation ensures a stock of sandal which is highly desirable from every point of view as compared with a stock of sandal which is the result of artificial propagation is a matter for close study. Experiments in this direction have already been

undertaken in North Salem Division. If it is found that the sandal stock of natural regeneration is the more suitable and that artificially regenerated sandal plants are susceptible to the attack of spike disease for example, it becomes a matter of paramount importance that we should take steps to encourage natural regeneration as widely as possible and give up attempts at artificial regeneration in spiked areas.

Lack of natural sandal in certain places possibly due to the presence or absence of certain animals or birds or their enemies.

It has been a matter of speculation why certain areas are entirely free from any trace of sandal growth while similar areas in close proximity bear a heavy growth of sandal. Is it possible that those animals and birds responsible for the natural distribution do not find the ecological environment favourable? Is it possible that in the area where sandal does not grow, enemies of such animals and birds exist? This is a very important point to be settled because it would lead to a flora entirely devoid of sandalwood. In such circumstances it would be impossible to encourage the growth of sandalwood in that area through natural means alone. With a view to investigate this point a series of experiments were carried out to see if the non-distribution of sandalwood in a particular area was the result of the absence of animals and birds which feed on sandal seed.

There is also another point which is to be borne in mind in connection with the natural regeneration of sandal, and that is, there are certain species of animals which do not devour sandal seeds but which feed on the sandal seed itself and utilise the endosperm of the seed which has been found to be highly nutritious. To this class of animals belong rodents and hares. These animals feed on the sandal seed and destroy it; in other words, the possibility of their germination if they were left alone is entirely removed.

There are a few other areas, sandal plantations in particular, which are near hillocks and where the natural regeneration of sandalwood is entirely absent. This point was further investigated and it was found that the non-existence of seedlings was due to the large number of rats that infested the area and consumed almost every seed that was dropped from the mother trees. Therefore, it is clear that

a circumstance of this character is inimical to the natural regeneration of sandal and perhaps it would also be inimical to artificial propagation through dibbling. A definite number of sandal seeds were kept in two or three areas with a view to find out if there were any fauna which ate the seeds. Their presence would be detected by the disappearance of the seeds kept in the area, while their absence would be indicated by the seeds being left untouched. One would expect that in an area where the sandal seed has not been touched there would be a profuse regeneration of sandal from the seeds while in the other area where the sandal seeds have been consumed there would be no natural regeneration. Observations confirmed this suspicion more especially in the Deverbetta area.

Natural spread of sandal in North Salem Division.

In spite of the unfavourable factors mentioned above, it may be broadly stated that the area under natural sandal has been slowly and gradually extending itself in narrow belts along the fringes of old sandal tracts of the North Salem Division. These tracts, as they then existed in isolated patches, were indicated on a stock map prepared under the direction and supervision of Colonel Campbel Walker in the year 1869. The extent of the sandal area then was 8,540 acres and now the areas between those patches are fairly stocked with sandal—the present extent being 93,563 acres. The same is the case with East and West Vellore Divisions too. This process of natural spread of the species is no doubt slow but considering that it has had to contend with so many adverse influences, the progress it has made within the past 66 years is very encouraging.

(*II*) *Why should sandal generally confine itself to lands once under cultivation and its immediate neighbourhood?*

The following are the most important factors that favour the natural reproduction in such areas:

(*a*) The worked up and friable condition of the soil serves as a good seed-bed and facilitates the germination of sandal seeds.

(*b*) The lateral roots of existing sandal trees, if any, are exposed and injured during the process of tillage and root-suckers shoot up at injured points and supplement the young crop of seedlings.

(*c*) The young coppice regrowth of bushes protect the tender seedlings against cattle and wild animals and shelter them from injurious effects of the sun, rain, and violent winds.

(*d*) The young and vigorous roots of the coppice growth provide the tender sandal with nourishment.

(*e*) Immunity from fire due chiefly to heavy grazing.

(*f*) Admission of light and air to the seedlings and to the soil with the sufficient protection that the coppice bushes afford against the scorching rays of the sun.

The chief method of aiding natural regeneration has already been dealt with.

(vii) Tending of natural sandal.

Other factors such as rigid protection from grazing and fires and introduction of scientific tending in sandal areas are also highly beneficial in encouraging the regrowth of sandal. This scientific tending aims at—

(*a*) Maintaining good host plants near the trees. In the dry areas of Coorg, North Salem, South Arcot and such places, hosts of *Melia indica, Semecarpus anacardium, Zizyphus jujuba, Erythroxylon monogynum, Strychnos nux-vomica, Dodonea viscosa, Webera corymbosa*, etc., can specially be encouraged in addition to a certain amount of *Albizzias*. Undesirable species such as lantana, *Acalypha*, etc., may be eliminated but their space should be quickly planted up with other species.

(*b*) Avoiding severe damage to host plants by girdling, felling, lopping or pollarding. If the injury to host plants is unavoidable, such as dying of bamboo clumps, the neighbouring sandal trees should be pollarded or coppiced in rich areas if sufficient good hosts are not available. New hosts should, however, be established near them as quickly as possible.

(*c*) Providing for the free and natural expansion of the crown from early youth.

(*d*) Freeing very carefully and gradually those trees which have become more or less suppressed.

(e) Providing light side shade to avoid damage from drought and sun scorch.

(f) Providing free overhead light or in dry localities of a very light overhead shade such as that provided by *Acacia suma or leucophloea*.

(g) Not allowing a heavy growth of grass or herbaceous plants to develop near the trees. Such plants are bad hosts as they create root competition, supply very little water or other material to sandal and create a badly areated soil, *e.g.*, lantana.

(h) Avoiding compacting the surface of heavy soil by over-grazing.

(i) Freeing the crowns of host plants from creepers, suppression, etc., and providing enough space for their development.

As the value of sandalwood trees increases, depending upon the number of sound and straight billets that are available from a tree, care should be taken in tending operations to draw the trees up as straight as possible by keeping enough side growth, cutting off all unnecessary side branches when not more than one inch thick close to the stem. If the branches are thicker, they should be cut off a few inches away from the sides, otherwise we are likely to introduce rot into the stem which reduces the value of the wood. It should be remembered that the sandal tree is very subject to heart-shake.

The above is by far the cheapest method that can be adopted to increase the amount of sandal.

(B) Artificial Reproduction.

General.

The question whether the existing natural sandal areas can be relied upon to produce all the sandalwood that can be consumed annually or whether it should be supplemented by artificial plantations to meet the demand has to be dealt with. The very fact that Australian sandalwood is imported into India and other countries at a cheap rate indicates that the supply of Indian sandalwood is not enough to meet the demand and that the cost of production is also high as compared with that of Australian wood. Therefore it is very essential to increase the output considerably and at a far cheaper rate.

Artificial methods of propagation.

The methods of propagation that are in vogue at present are—

(1) Sowing *in situ.*

(2) Raising plants in the nursery and then transplanting them.

(3) Raising plants in the nursery and stump-planting them.

(4) Root-suckers and root-planting.

(1) Sowings "in situ."

This is possible only in open scrubby or semi-evergreen types of forest. Blocks of forests are selected and handfuls of seeds are sown underneath the bushes by scratching the soil, dibbling the seeds and covering them up with a layer of dry leaves so as to make the place look undisturbed. The seeds are sometimes treated with a paste of *Acorus calamus* (Tamil—*vasambu*) to prevent rodent from attacking the seeds. The seedlings that come up immediately form haustorial connections with the tiny roots of grass and bushes. When they grow bigger they attach themselves to the roots of bigger trees in the area. Covering of seeds with dry foliage is also done as a preventive against rodent attack. From 1864 to 1878 this method was chiefly adopted both in Mysore and Madras. In this kind of *in situ* sowings in several localities the percentage of success was poor, but by going over the same ground year after year for six to eight years a stock has eventually been established. Many of our old areas, *e.g.*, Chittoor, North Coimbatore, Naihalla, etc., were raised by this method. The reason for adopting this particular method at the time was the complete failure of plantings.

From 1878 these *in situ* sowings were replaced by transplanting done with plants raised in tile pots. This was in vogue till 1895 or so, when *in situ* sowings were again brought back due to failure of plantations after 10 to 12 years. This no doubt is the cheapest method and would be the best if the high percentage of success aimed at was obtained. The best time for such sowings is the beginning of the monsoon just before the early south-west showers moisten the ground. The western zone has this advantage over the central or the eastern since the early rains from the south-west are

usually sufficient to ensure the germination of seed; and thus the resulting seedlings are five to six months old when the dry season sets in. But in the other classes of forests described elsewhere there is not sufficient continuous rain required for the germination of sandal until the north-east monsoon starts in October. The seedlings resulting from sowings here are only two months old when the dry weather commences and a high mortality occurs in about a month after the dry weather begins. If the plants withstand one dry weather, then they are unlikely to die, provided the host conditions have been amply provided for.

(2) *Raising plants in the nursery and transplanting.*

As already pointed out, the introduction of tile pot nurseries started in 1878. Seedlings were raised in pots and transplanted in the field. From 1878 to about 1900 transplanting was resorted to in all places. Not only dry areas but also high forest types of evergreen were selected, all growth was cut and burnt. In some places big pits 2 feet × 2 feet × 2 feet were dug up and in others the planting was done in crow-bar holes. Most of the plantations done by the pit method failed within a year or two whereas those done in crow-bar holes appear to have been very promising up to the age of 10 or 12 years, and have shown signs of failure after that age. Only a few of such plantations are found now both in Coorg and in Mysore.

The reasons for such failures are obvious. The silvicultural characteristics and the parasitic nature of the sandal plant was not fully appreciated in planting sandal in a completely opened out area. Total clearing and burning was the initial mistake. Big pits and planting without a primary host aggravated it, but the success in some cases, especially those planted in crow-bar holes, was accidental. The seedlings were able to haustorise on underground roots and continued to grow until some other trees were available. As the big trees had been destroyed the parasite had to suffer after about 10 years when they could no longer take enough material from the shrub or weed growth.

The different methods of direct sowings and plantings have been discussed by Messrs. C. C. Wilson and Mitchell (1932). The above

methods are all followed for raising sandal in a suitably selected locality where a few sandal plants do already exist, thereby indicating that sandal will develop to maturity there. No attempts have been made to define the suitability of a particular site for sandal propagation in terms of either definite soil conditions or in terms of certain species of indicator plants which might definitely determine the fitness of a particular region for sandal propagation. Consultations with a number of experienced forest officers have shown that they go more by instinct than by any rational and scientific observations. This instinct has been in many cases fortunately infallible, but we should not depend for such large-scale enterprises upon mere instinct. These enterprises should have a sound foundation of scientific reasoning so that it should be possible even for a layman to determine the fitness of a particular locality for sandal growth. Attempts in this direction are now being made by several forest officers both in Madras and Coorg.

(3) *Stump-plantings.*

Although dibbling seeds under suitable bushes has been the chief practice adopted for the propagation of sandal there have come into vogue, more recently, a number of other methods of propagation which promise to show a good deal of success. Stump-planting is one of the methods ofpropagation which found favour in a number of localities.

In the earlier stages of the life history of sandal and (*i.e.*) during the first two years, sandal needs extra protection against the ravages of rodents. If this period could be spent in a nursery where the plants could be looked after more carefully the cost of protection of these seedlings for a period of two years when grown in extensive areas under field conditions could be saved. Further, the success attending the stump-planting, if carried out during the monsoon, is high, a large percentage of them survive the hot weather and they establish themselves permanently during the following year.

The method consists in raising sandal plants in the nursery for two years. The plants are then pulled out, the stem portion is cut off leaving only 1 or 2 inches and all roots are trimmed leaving about 9 inches of the tap root. The stump thus prepared is then planted with a primary host in a crow-bar hole or pit. The planting has to be done

during the monsoon and the soil should be well pressed round the stems so as not to leave any vacant space inside. (Plate No. 35, Fig II. shows the stump prepared and plants raised.)

Suitability of locality.

The method of propagation that is adopted for sandal regeneration is dependent upon locality, climatic and other environmental conditions obtaining in the area. Methods found suitable for regenerating sandal in a Midan are not generally suitable for establishing it in Malnad. Again, those that are suitable for the propagation of sandal in scrub type of jungles are not suitable for the propagation of sandal in high forests. A locality which is infested with a certain type of rodents and herbivorous animals like the sambhur may not be suitable for sandal propagation till special methods of protection are enforced.

The germination of sandal has been the subject of study more recently by a number of forest officers in Madras and Coorg, particularly by Mr. Mitchell who found that the germination of sandal seeds can be greatly accelerated in cold weather if the germination beds are covered with straw. The seedlings are then transplanted along with a suitable host plant preferably *Acacia farnesiana* which provides the necessary nourishment during the course of its first year.

Scope of stump-planting.

Stump-planting may also be adopted as a routine procedure in cases where a large number of young plants are available. As detailed elsewhere, fairly well developed sandal plants can be easily established around mother trees. It is also not uncommon to find plenty of plants naturally growing under sandal trees. Such plants are a drain upon the hosts and do not in the long run give any return of heartwood to the department; a thinning out of these plants would really favour the development of the other stock and encourage their rapid growth. The material available during this process of thinning out may be used for stump-planting. It has been found that a sandal plant can be successfully stump-planted in its first, second, third, or fourth year. These stumps will commence to send out young shoots and

establish haustorial connections in the course of three months. Large-scale experiments carried out in the experimental plots at Denkanikota have given from 50 to 98 per cent. of success.

(4) *Root-suckers and root-planting.*

Another type of regeneration which is not extensively practised but which can be done in areas where there is already some sandal is propagation through root-suckers. It is a common observation that when sandal roots are injured in the course of trenching, the exposed root gives rise to shoots which subsequently develop into practically independent plants establishing their own connections with other host plants.

This method also has the disadvantages of raising plants under the mother tree, but where there are a sufficient number of host plants this mode of propagation may be encouraged. In recommending this method of propagation it should be emphasised that the new plant should be capable of establishing connections with new host plants and not compete with the ones nursing the parent plant.

Root-planting.

There is also another method of propagating sandal by planting pieces of roots. Lateral roots of sandal, about an inch in girth and about 9 inches in length, are planted longitudinally within an inch or two below the ground level with a vigorously growing primary host. Within a month clumps of shoots come up from one or both ends. These shoots grow beyond the reach of cattle within a year. (See Plate No. 35, Fig III.) The amount of success that has been obtained by this method of propagation is only 15 to 20 per cent. under controlled conditions and so far no large-scale experiments have been done in this direction.

General.

All these methods of propagation, stump-planting, propagation by roots and root-suckers and also transplanting have the great merit of being able to establish an already well developed sandal plant in a suitable area. In addition to the fact that we are able to save the cost of protection during one of the most critical periods in the

life history of sandal we have the assurance that the planted sandal will have better promise of success. These methods are particularly suitable to and economical in areas where there is over-grazing and where the seedlings that have just come up are likely to be nipped off by deer. They are also suitable to areas where soil conditions do not permit a healthy germination of seeds when dibbled. These methods of propagation should be adopted in the Malnad areas and also in areas which do not get the south-west monsoon showers.

The formation of haustorium in the earlier stages is possible only with plants, especially the legumes. When once the haustorial formation is stimulated by such a measure, further haustorisation of many species of host plants becomes easy. So, from this point of view, the method of transplanting or stump-planting is doubly safe.

My thanks are due to Mr. A. L. Griffith, I.F.S., the Provincial Silviculturist who was kind enough to edit the paper, and also to my district forest officers who gave me all facilities to carry out the experiments. My thanks are also due to Mr. M. Sreenivasaya, F. I. I. Sc., for his valuable suggestions in drawing up this report.

BIBLIOGRAPHY.

1. Notes on Sandal Tree in South India, P. M. Lushington, 1900.
2. Notes on Sandal, M. Rama Rao, 1904.
3. Notes on Sandal, P. M. Lushington, 1904.
4. Notes on Sandal, M. Rama Rao, 1908.
5. Germination of Sandal Seed, Geo. W. Thompson, 1913.
6. Proceedings of the Conference on Spike Disease of Sandal, 1917.
7. Troup's Silviculture of Indian Trees.

Notes on the Artificial Regeneration and Tending of Sandal, Messrs. C. C. Wilson, I. F. S., and J. E. M. Mitchell, I. F. S., 1932.

REVIEWS

MALAYAN FOREST RECORDS No. 12

COMMERCIAL TIMBERS OF THE MALAYA PENINSULA No. 1—THE GENUS SHOREA By H. E. DESCH. With Botanical Notes by C. F. Symington. (Price 2s. 6d.)

In 1919, Reyes published his work on the woods of Philippine Dipterocarps. Since then, no other critical study of this commercially important group has been made and now, after so many years, the commercial timber of Malayan Shoreas has come out. A glance through this book will give one an idea of the progress that has been made in the subject of Wood Technology during the last few years. The author does not naturally claim that his method of describing the wood is perfect but it must be said that he has done very good work, considering the present state of our knowledge. Forty-seven species are dealt with under six groups. Each group starts with general remarks and then botanical identity, vernacular names, distribution and habit. The timber is treated under general property, macroscopic features, microscopic features, differentiation between species, mechanical properties, importance and uses, confusion with other species and other related species. All botanical notes have been supplied by Mr. Symington, the Forest Botanist, who has, after careful study, placed two Balanocarpus species under Shoreas. Seventeen tables have been included and these give details of anatomical features. There are also twenty-nine photomicrographs at x 5 and x 35.

Shoreas are much greater in number in Malaya than in India, and the Malayan Shoreas show more variation in their anatomical structure than our Indian species. Except for a few differences such as absence of horizontal resin canals in the Indian species, a general similarity in the anatomical structure in the Shoreas of these two countries is noticed. In the matter of growth rings, the findings of the author of this record seem to be entirely in agreement with those of ours in India.

The question of classification and identification of the woods of different genera and species of the *Dipterocarpaceae* does not appear

to be so easy as it seemed a few years ago. With our increased knowledge of their anatomy it has become rather a complicated problem, for woods of certain genera show such extreme similarity that one cannot say with confidence to which genus or species a timber from an unknown region belongs. If one could obtain sufficient wood samples of all the species of the *Dipterocarpaceae* and make a critical study, the problem would perhaps be solved, but at present nobody is in a position to take up this work. The reasons are: firstly, Systematic Botanists are not in agreement regarding the identity of many species, and, secondly, there are difficulties in obtaining enough wood specimens. In these circumstances the course taken by Mr. Desch seems to be in the right direction. If workers in different countries study thoroughly the various members of the *Dipterocarpaceae* present in their countries and published the results, it will finally remain for someone to make a critical study of these publications and draw up a workable key for all the genera and species of the order.

K. A. C.

ABSTRACTS OF INDIAN FOREST LITERATURE PUBLISHED DURING THE QUARTER ENDING THE 31ST MARCH, 1937

MARRIOTT, R.G. *The resin industry in Kumaun compiled in the Kumaun Circle. U. P. For. Bull.* No. 9: *pls.* 5, pp. 1-26, 1936.—Gives the history and development of the Resin-tapping industry in the *Pinus longifolia* forests in Kumaun with up-to-date details of the actual methods of tapping, etc., the silviculture and management of the forests concerned, work in the resin factory including methods of distillation, and data for the output of resin and past and present prices.—*M. V. Laurie.*

KRISHNA, S., S. V. PUNTAMBAKER AND M. B. RAIZADA. *Minor Forest Products of Chakrata, Dehra Dun, Saharanpur, etc., and neighbouring Forest Divisions. Part I. The oil-bearing Seeds. Ind. For. Rec. (New Chem. Series).* I (1): pp. 1-44, 1936.—The physical

and chemical constants, the constituent acids and the uses of oils and fats from the seeds of 56 Indian plants commonly occurring in forest divisions round about Dehra Dun are recorded under the headings (1) Drying Fatty Oils. (2) Semi-drying Fatty Oils, (3) Non-drying Fatty Oils and (4) Solid Fats and unclassified Fatty Oils. A brief botanical description of each plant including its vernacular name, habitat and relevant references to scientific literature are also given. In the introduction the authors state that this information will be useful both to business men and research workers interested in plant products.—*S. Krishna*.

ANDREWES, H. E. *Some New Carabidae from India. Ind. For. Rec. (Ent.) II (8)*: pp. 177-180, 1936.—The following new genus and new species are described: *Chleanius auripilis* sp. n. (U.P., Dehra Dun); *Abacetus iricolor* sp. n. (U.P., Dehra Dun); *Dilonchus* gen. n. with type *D. bidens* sp. n. (U.P., Dehra Dun)—*J. C. M. Gardner*.

GARDNER, J. C. M. *Immature Stages of Indian Coleoptera* (20), *Carabidae, Ind. For. Rec.* (*Ent.*) *II* (9): pp. 181-202, 4 *pls*, 1936.—Larvæ of certain species of the following genera are described: *Orthogonius, Trechus, Broscus, Dilonchus, Amblystomus, Amara, Abacetus, Chlaenius, Callistomimus, Scarites, Calathus, Masoreus, Caelostomus, Mochtherus, Coptodera, Dromius, Metabletus, Cymindoidea*. *Author's abstract*.

KLEINE, R. *New Species of Brenthidae and Lycidae from India* (*Col.*). *Ind. For. Rec.* (*Ent.*), *II* (10): pp. 203-206, 1936.—This paper describes three new species of *Brenthidae*, *Baryrrhynchus bengalensis* from Kalimpong, Bengal, *Synorychodes glaber* (*Fig.* 1), Kurseong, Bengal, and *Hypomiolispa incerta* from *Anthocephalus cadamba*, Kurseong, Bengal.

Two new species of Lycidae, *Lycostomus paucicostatus* from Trichinopoli and *Calochromous setiger* (*Figs.* 2-5), Sadiya, Assam, are described.—*J. C. M. Gardner*.

CHATTERJEE, N. C. *Entomological Investigations on the Spike Disease of Sandal* (30) *Reduviidae* (*Hemipt.*) *Ind. For. Rec.* (*Ent.*) *II* (11): pp. 207-221, 1936.—This paper lists 42 species of Reduviidae frequenting the foliage of sandal (*Santalum album* Linn.) collected by

the Forest Research Institute survey of the insect fauna of that tree in North Salem, Vellore, Madras and North Coorg Forest divisions, South India.

Of the 42 species, 20 were found in Aiyur and Kottur and 18 in Fraserpet and Jawalagiri. Brief notes on the life-history and bionomics are added and a table showing the distribution and abundance of the various species is given.—*Author's abstract.*

CHOWDHURY, K. AHMAD. *A fossil dicotyledonous wood from Assam. Ann. Bot. L.*, CXCIX., p. 501-10, 1936.—The author describes *Glutoxylon assamicum* gen. et sp. nov. from the Tipam Sandstone Stage of Assam. Its similarity to *Dipterocarpoxylon burmense,* Holden (*Irrawadioxylon burmense,* Gupta) and *Dipterocarpoxylon annamense,* Colani, are discussed. Doubt is also expressed as to correct identification of these dipterocarpoxyla and suggestion is made to re-examine them in order to place them in their legitimate systematic position. Some anacardiaceous fossils, namely, *Anacardioxylon uniradiatum,* Felix. and *Anacardioxylon molli,* Krausel (*Sumatraxylon molli,* Den Berger) are compared with the fossil from Assam and their dissimilarities are pointed out.—*K. A. Chowdhury.*

RAMASWAMI, S. *On Indian Woods Tested for Match Manufacture. Published by the Forest Research Institute, Dehra Dun,* pp. 14, 1935.—The result of tests conducted at the Forest Research Institute, Dehra Dun, and in various match factories in India, on seventy-eight species of Indian woods, regarding the suitability of these species for the manufacture of match splints and boxes are given in a tabular form. The vernacular and the trade names of the species as well as their distribution in India are also given.—*H. Trotter.*

NARAYANAMURTI, D. *The electrical resistance of wood and its variation with moisture content. Curr. Sci.* No. 8, p. 79, August 1936.—Results of preliminary experiments conducted by the author on the variation of electrical resistance of wood with moisture content are reported. The results indicate an approximately linear relationship between the logarithm of the resistance and the logarithm of the moisture content below the fibre saturation point.—*H. Trotter.*

KAMESAM, S. *Wood's Challenge to Steel and Concrete. T. D. Pamphlet No.* 1: pp. 1-5, *pls.* 4, 1936.—A strong case for treated wood is made out as one of the most advantageous materials for modern structural purposes. It is stated to be:

(*a*) *Light;* its weight being for a standard strength, about one-fifth that of concrete and the same as for steel.

(*b*) *Economical*; costing only one-fifth the price of concrete or steel.

(*c*) *Strong*; it being possible to obtain full strength by careful joints.—*H. Trotter.*

KAMESAM, S. *Relative Economy of Wood, Steel and Concrete Structure. T. D. Pamphlet No.* 2: pp. 1-6, *pls.* 2, 1936.—The relative economy of wood, steel and concrete structures is discussed. Typical examples of loading demonstrate that wooden beams and columns are more economical than reinforced concrete and steel.—*H. Trotter.*

EXTRACTS

DO HATCHERY TROUT "GO WILD?"

BY RUSSELL F. LORD.

In charge, U. S. Experimental Trout Hatchery, Pittsford, Vt., U. S. A.

Some people think that hatchery trout are as far removed from a real trout as a Caspar Milquetoast is from Mussolini. They deem them nothing but caricatures of the fish that once filled our clean, cold streams and lakes. They judge them helpless, unfit, over-fat, tasteless, pampered degenerates raised at great expense and turned loose to perish unless some deluded angler catches them first as a substitute for real fish.

If these contentions are accurate, then the fishermen of our land are in a bad way indeed, for no other way is left to provide fishing at home except to release these same hatchery-reared trout.

It has been said time and time again that trout are just incidental to the outing that the real joy of fishing lies in the blue sky overhead, in the bits of bird song, and in the play of sunlight and shadow on the rifles. All very nice, but show us a man who does not feel ever so much more appreciative and soothed if the trout are there and rising and if his creel sags a little heavier as the hours pass!

Full creels to-day, however, would indeed be rare if it were not for the restocking of trout waters by States, Government and sportsmen's clubs everywhere. Each year there is a cry for more and larger fish and each year sees our streams whipped harder. It is no wonder that, with the demand for an ever-increasing output, our fish-rearing establishments have not had much time to see if they were turning out the best sort of trout possible. Trout-rearing at its best is a gamble and all too often the fish culturist is too busy being thankful for any kind of output to do much worrying about any shocking differences between the appearance and behaviour of his pets and the wild fish they are intended to replace.

Fortunately, there has been so much learned about the feeding and care of trout that it is no longer necessary to turn out ludicrous imitations of the genuine article. It is possible to raise trout at hatcheries in no way inferior as to shape, colour and vigour to the typical wild fish. I do not say that this is being done everywhere, but it is possible where environment and diet are correct.

Such an improvement in hatchery trout is the result of years of experimenting not only by the United States Bureau of Fisheries but by other agencies. For example, the Bureau of Fisheries in 1925 turned over a trout hatchery at Pittsford, Vermont, to be devoted entirely to research in trout culture. The business of this hatchery is to make the fishermen of the country more agreeable people to live with by finding means to provide them with bigger and better trout at less expense. Thus, studies in the diagnosis and control of fish diseases, elaborate feeding tests, selected breeding work, and a programme of stream improvement and related studies of trout stream production have all played a part in the task of restoring our overworked trout waters to a semblance of their former status.

The starting food usually used at the Pittsford hatchery is finely ground beef heart or liver. Heart, lungs, liver and spleen of swine, sheep or cattle are time-honoured hatchery foods. Fish is also used extensively in some situations. At Pittsford various dried products, when mixed with finely ground liver, make the trout grow faster. Dried foods successfully used have been fish meal, meat meal, dried buttermilk, clamhead meal and others. Salmon egg meal makes the fish grow faster and gives better colour than the others. The food bill is always the chief item on the list of hatchery expenditures. Dried foods must never be used alone; some fresh meat is required to keep the fish in condition.

The present article, however, considers only the results of some experiments designed to find out whether the trout produced in the course of the work would be worth anything as game fish.

The first test involved 100 marked brook trout liberated in August of their second summer in an excellent trout stream adjoining the hatchery. The primary object of the experiment was to see if the fish were capable of finding their own food soon after planting or if there would be a gradual period of adjustment to a new environment. Their behaviour as sporting fish was, of course, of equal importance.

It was planned to give the fish approximately 24 hours liberty and then to commence taking a daily sample of ten fishes with rod and reel until all, or as many as possible, of the fish were recaptured.

On the day following liberation the first assault was made on the planted trout. As I approached the brook I admit having felt a bit excited, for I was intensely interested in seeing whether those trout would respond to flies in true game-fish fashion. There was not long to wait! In the fast current of the first liberation pool a trout hit the gray hackle with force and accuracy, and from the rise until he twisted on the shore he did his best to undo his fatal mistake. An angler who found fault with that battle for freedom would be a hard person to please. As I went about the business of preserving the stomach in a bottle of formalin for future study, and setting down the data as to the place of capture and so on, I found myself wondering if this well-behaved fish was the exception, but before the daily sample

had been taken all doubts had vanished. Those hatchery fish needed no one to apologize for them in any respect. The brook itself was low and clear and it was soon found that as much care was necessary in approaching pools as in any ordinary fishing, as sudden movement on the shore would send the fish darting for cover as if they had spent all their lives in avoiding mysterious shadows on the edge of their watery world. When they decided to take a fly they struck hard and acted as trout should act. Due to a diet designed to bring out the colours, they were as brilliantly marked as the ordinary wild fish. And, incidentally, the flavour of the specimens was not to be adversely criticized!

Not only were these fish proving to be on the alert for food, but they were actively competing with the trout already present in the stream. For example. On one cast the angler hooked and landed not one fish, but two. A wild rainbow and one of the newly-planted brook trout had both struck the moving flies and of the two fishes the brook trout was more firmly hooked. Rainbow trout have a habit of getting under way like lightning once they decide on something tempting, but the hatchery-reared brook trout was equally alert.

The stomach of the brook trout showed an interesting assortment of food. The posterior end still contained remains of the last hatchery meal, while the anterior end contained 13 freshly taken caddis worms and a few mayfly nymphs. This did not look as if the pampered hand-raised trout had been very much handicapped by its former confinement.

Fishing continued until 82 of the 100 brook trout were recaptured and every moment of it was real fishing. The trout responded when it pleased them to do so and before the final score could be tallied the anglers were forced to resort to a variety of lures. The fish definitely did not "come easy."

Every stomach was preserved and contents analyzed. If it is assumed that hatchery trout must gradually learn to forage for themselves because of their new environment, we might expect to find a steadily-increasing number of food organisms in the stomachs as time passed. Such was not the case. Nothing resembling a daily increase

in the amount of food was observed. The only conclusion possible, therefore, is that hatchery environment had little deleterious effect on the ability of the fish to forage for themselves on short notice. In fact, the average number of insects per stomach was very close to that found by another investigator who examined the stomachs of a large sample of wild trout from New York State waters.

It is not surprising that hatchery fish can take up the business of foraging. One has only to observe a pond of fish during the summer when the midges are active or a hatch of mayflies is on in a nearby stream. I have seen fish jumping in the Pittsford ponds so steadily that dozens of them were in the air at once, and kept it up as long as the insects were active. At other times the fish in the ponds have been observed working over the bottom gravel, picking it up in their mouths and ejecting it with force. This winnowing process allowed the heavier gravel to sink while the midge larvae, which represented the gold of the mining activities, were snapped up before they settled to the bottom. Often too, when fingerlings are being transferred to outdoor pools, the first pailful of transplanted fish can be seen revelling in their freedom and jumping for low-flying midges before the second pailful of young fish has been brought from the hatchery. From my observations it seems that a trout on being liberated is as pleased as a small boy quietly raiding the ice-cream freezer on a school picnic. Everything is his : lots more of his favourite food and nobody to curtail any little whim !

The general conclusion is that the anglers of our country need no longer feel too downcast over the passing of typically wild trout. Hatcheries can, if they follow the right methods, rear trout capable of taking care of themselves on being planted and that will be pleasing to the anglers as game fish. This cannot be done, however, by holding fish in an unsuitable environment and feeding them the first thing that comes handy. Not all hatchery-reared fish can be expected to meet the requirements. The hatchery environment should approach as closely as possible the waters to be stocked. Over-fed trout reared in relatively warm, crowded pools cannot any more be expected to make good in a cold, swift stream than a soft city man can be

expected to duplicate the feats of his northwood's guide. In short, our trout-fishing near home is entirely up to the hatcheries, and it is up to the hatcheries to see to it that the fish put out are something worth the expense of rearing and the effort of catching. The bright spot is . . . *it can be done.*

[*Sportsmen can do much to promote better fishing in their localities by urging scientific methods in their own hatcheries. More emphasis should be placed on better fish than on quantity production.*—THE EDITOR, *Scientific American.*]

(*Scientific American*, May 1936.)

PROBLEMS UNDER INVESTIGATION AT THE FOREST PRODUCTS LABORATORY OF CANADA

(NEWSLETTER NO. 15, DECEMBER 1936.)

Steady progress has been made in Europe in the development of producer-gas equipment for automobiles, trucks, and tractors, as well as for stationary engines. In Great Britain many stationary engines, of all sizes up to as high as 500 horse-power, are operating successfully on producer-gas, while in Germany alone there are over 2,000 automobiles using wood-gas and this type of fuel is well established.

The success which has followed investigations in Europe, combined with the high cost of gasolene and fuel oil in isolated districts of British Columbia, have resulted in considerable interest being shown in this subject locally. Consequently, the Vancouver Laboratory of the Forest Products Laboratories of Canada has made a series of trial runs to determine the efficiency of producer-gas developed from charcoal made from selected species of British Columbia woods.

The selection of wood species for investigation was influenced by the timber obtainable in the districts of the province in which producer-gas equipment would be likely to have special application. The relative efficiency of the various charcoals tested was determined by means of road trials using a $1\frac{1}{2}$-ton truck equipped with a charcoal-gas generator.

There are two main factors to be considered in determining the value of the different species of charcoal for use as producer-gas fuel. The first is the amount of power obtained and the second is the physical characteristics, such as freedom from dust, hardness, etc., which influence handling of the charcoal.

The relative cost of operation of the test truck using charcoal of different species and gasolene is shown below and indicates a considerable saving by the use of producer-gas. The costs are based on charcoal at $20.00 per ton and on gasolene at 30 cents per gallon :

Relative operating cost with different fuels.

Douglas fir cordwood charcoal ..	0·24	cents per	ton mile
Red alder charcoal ..	0·26	,,	,,
Lodgepole pine charcoal ..	0·27	,,	,,
Cottonwood charcoal ..	0·30	,,	,,
Gasolene ..	0·57	,,	,,

CHEAP POWER PRODUCTION

POTENTIALITIES OF WOOD FUEL AND CHARCOAL FOR CHEAP POWER PRODUCTION IN INDIA

By S. Kamesam

Timber Development Officer, Forest Research Institute, Dehra Dun.

The fuel and power resources of a nation play no small part in its industrialisation. Although primarily an agricultural country with comparatively limited natural resources of iron, steel and coal for the development of large-scale industries, India is nevertheless fast becoming one of the leading industrial countries of the world. About a third of the total area of the country is agricultural land and about the same area is covered by forests, so India should endeavour to get the best out of her agricultural and forest resources. Although nearly a million horse power of electrical energy is being generated annually, India is comparatively poor in coal and oil, the latter being essential for obtaining the maximum efficiency out of engines,

especially the engines in the mofussil and those used for driving vehicles. Diesel oil, kerosene oil and petrol, to the extent of several crores of rupees, are being imported annually into the country. Other countries that are poor in oil resources have been endeavouring to develop substitutes. In England, a large factory for manufacturing oil from coal for power purposes has recently started working. In France, Italy and Central European countries, the possibilities of wood and charcoal gas for power and traction have been rapidly developing during recent years. There is no reason why these cheap and universally available sources of power should not bring prosperity to this country also, and especially to the Indian villager, who will not, in most areas, be able to obtain the benefit of cheap electric power for a long time to come on account of the comparatively high cost of electrical transmission and distribution. Until inexpensive wireless broadcasting of power becomes a reality, some type of power generation should be made available to the Indian villages, and that, if possible, by using agricultural wastes or materials that are easily obtained in the immediate vicinity of most Indian villages.

INTENSIVE RESEARCH.

In the light of recent intensive research in Europe it would appear that wood gas holds for India about the best key for solving the problem of affording cheap power to practically every village in India. The utilisation of wood gas for power and traction is no longer in the experimental stage. In Germany there are already many hundreds of wood gas fuelling stations distributed all over the country. A book recently published in Germany gives the position and addresses of over five hundred such fuelling stations. It is well known that in the destructive distillation of wood, a gas with a high calorific value is liberated. This gas after admixture with air can be exploded by an electric spark to produce power in the same way as petrol vapour mixed with air. The use of wood charcoal gas was in fact the forerunner of petrol gas. Wood gas has been employed for illumination purposes for over 100 years in Linz and Salzburg. The liberation of wood tar and acetic acid when wood is destructively distilled and the

consequent blocking or corrosion of the containers and pipes stood as barriers for a long time in the way of employing wood gas for driving engines, either stationary or portable. During the Great War, several charcoal gas-driven lorries were used in France.

Practical Proposition.

It is, however, only during the last four or five years that most of the difficulties in the construction and operation of wood gas producers have been circumvented, and in the memorable race organised last year by the Automobile Club of France motor cars and lorries driven by wood gas showed themselves to be a most practical proposition. The race demonstrated that such vehicles could compete very favourably even as regards ease and facility of operation with the most modern types of petrol-driven vehicles. It was also reported very recently that an Italian motorist travelled 4,000 miles in his car employing only one cwt. of wood charcoal. Instead of using an end product like charcoal, as was done before, wood which is available almost everywhere and in its natural form can now be used without any trouble. This has been science's recent big step.

Gas Producer Features.

In modern suction gas producers, wood or wood charcoal is fed into a steel cylindrical apparatus which, when used for traction purposes, varies between $1\frac{1}{2}$ feet and 2 feet in diameter and 3 feet 6 inches and 6 feet in height, depending on the horse power required to be generated. While a wood gas producer can be used for operation also with wood charcoal, the reverse is not the case. A wood gas producer is longer than a charcoal producer because in the upper part, the wood is first converted into charcoal by a process similar to that which has been used commercially for a long time. The gas is produced by glowing charcoal coming into contact with air and steam at over 1,560 degrees C. This produces a tar-free gas of which the useful components are carbon monoxide and hydrogen. Recent experience has shown that wood gas along with tars and acetic acid should be made to circulate downwards so that the tarred and other products are decomposed.

LATEST TYPES.

In some of the latest types of machine, there is a red hot charcoal chamber in the centre, and wood blocks are loaded into annular space all round the charcoal chamber. The wood gas thus produced goes down the annular chamber first, and then up the charcoal chamber. The French " Brandt " type, which is considered one of the most efficient types by expert operators, works on this principle. In the case of charcoal in which there is hardly any moisture, steam has to be mixed with air for enabling a gas to be obtained with a calorific value that is comparable with that produced from wood, the moisture content of which should not, however, be more than 20 per cent. in the case of gas producers or generators that are used for traction. In the case of stationary engines, however, the moisture content can be as high as 30 per cent. and the length of wood billets may be as much as 2 feet. In the case of traction producers, the size of wood pieces should not exceed 3 inches in any direction. Hardwoods or softwoods with the minimum of oleo-resins are preferred, especially for gas generators that are used to drive vehicles. Softwoods are not usually recommended for traction producers.

AIR-COOLED GAS.

Before wood gas can be employed in engines, whether stationary or movable, the gas has first to be air-cooled in a suitable radiator and then passed through a specially designed cleaner or purifier which, except in the case of a few makes of stationary engines, is in all modern makes of the dry type. In the wet type of purifier the gas is allowed to bubble through water and considerable trouble has been encountered on account of " condensation " in the engine. Recent research has now developed an efficient dry purification system which involves perforated baffle plates, a wire cloth, wood, wool or cotton filters, and cyclone purifiers. The weight of a wood gas equipment varies between 2 cwt. and 6 cwt. corresponding to 8 h.p. and 40 h.p., respectively. In a 40-h.p. lorry, if wood is employed, 30 per cent. of the carrying capacity will be taken up by the wood and the wood gas equipment. By using charcoal briquettes instead of wood or charcoal

the saving in weight, as far as the wood fuel is concerned, is about 60 per cent. As far as the saving in space is concerned, it is about 80 per cent.

Fuel Consumption.

The greatest saving with wood gas in the case of moving vehicles is obtained when the runs are long and the stops are short. In the opposite case where the runs are short and the stops are long the consumption of fuel increases by about 25 per cent. in average cases. There were, some six months ago, about 2,500 wood gas producers working in Germany and over 10,000 in Austria. The German and Austrian railways have several wood gas producers running five-ton lorries. The average consumption of air-dry wood (beech) of these lorries is 5 lbs. per mile. If charcoal is used, the corresponding consumption is about 2 lbs. Numerous experiments by various investigators have shown that about 25 lbs. of air-dry hardwood like beech, or about 10 to 12 lbs. of hardwood charcoal, correspond to one gallon of petrol. Passenger cars have run on 1½ to 2 lbs. of air-dry wood or about half this quantity of charcoal per mile. Heavy lorries require 4 to 5 times as much fuel. According to reported Indian experience with charcoal costing Rs. 20 per ton, the cost of fuel per mile worked out at 1·6 to 2 pies, as against about 8 to 10 times as much for petrol. These are actual figures recorded by a heavy lorry that has run several thousand miles in a mountainous country in South India.

Vehicle Adaptability.

Wood and charcoal gas producers are available to run engines varying between 5 h.p. and 1,000 h.p. For the same degree of compression, a mixture of wood gas and air has a slightly lower calorific value than that of petrol and air. Therefore, for obtaining the best results, either the cylinder head of petrol driven cars should be adapted to obtain less space, larger pistons used or an extra piston added. A Diesel engine can be directly changed over to wood or charcoal gas with a loss of efficiency of only 10 or 20 per cent., so that it is a moot

point whether (except in cases where the cylinder head is removable and a special cylinder head for wood gas is available on the market) the expense involved in specially adapting petrol-driven engines to wood gas is justified.

ATTRACTIVE ADVANTAGES.

When wood gas is employed, besides effecting considerable savings in the running cost of stationary or traction engines, on account of the lesser degree of heat generated in the ignition chamber, there is less damage to valves and pistons besides less deteriorating action on lubricating oil which has consequently a longer life than in oil-driven engines. Wood gas is not so dangerous to life as petrol vapour although inhaling it directly should be avoided. Wood or charcoal gas-driven engines should be started with a small quantity of petrol. If no petrol is available for starting, about five minutes will be necessary to start on wood gas alone. Experience with several thousand lorries that have been in use all over the world (including the one in South India working in mountainous country) shows that a wood gas-driven engine is reliable and that it will run without frequent breakdowns. The maintenance consists chiefly in an hour's cleaning after every thousand miles run. Speeds of 60 miles per hour have been obtained with passenger vehicles and with heavy lorries about 32 miles per hour. In addition to being used for running motor cars and lorries, wood gas has a great field open to it in agricultural, forestal and rural industries. In the country, wood gas engines can be used for driving irrigation pumps, electric generating sets and for heating and illuminating. Small rural industries can thus obtain cheap power by using agricultural or forestal waste materials obtainable on the spot.

EXISTING USES.

Since the year 1927, during a period of seven years, the French Government spent nearly 50 million francs on perfecting the wood gas producer. Although the State obtains four milliards of francs annually as taxes on petrol and power oil, the French Government

is now endeavouring to convert all power units in the country to wood gas. The work of erecting wood gas fuelling stations in different parts of the country, as has been already done in Germany, is now rapidly progressing in France. In Germany and Italy considerable developments have been witnessed during the last few years. Wood gas-driven engines have become eminently practicable and there are now several firms manufacturing wood and charcoal gas producers in these countries. France, Germany, Italy and Austria are the leading countries in the utilisation of wood gas.

Universal Utility.

Italy is using 875 million cubic feet of grape vine wood for producer gas. This material was burnt in a highly uneconomical manner before. With some research, it might be possible to use some such waste materials as cotton stalks or bagasse in India for generating producer gas. Switzerland, Sweden, Czechoslovakia, Holland, Finland, Japan and Russia have all entered the field of wood gas producers, and have already contributed considerable work to the subject. The Government of the Chinese Province of Kuantang have ordered that all motor lorries in that province should be converted to wood gas within 18 months. The result has been that there are already several hundred lorries running on wood gas, and there are two firms in Shanghai making wood gas producers. It is also reported that the Japanese authorities are convinced that they can produce a touring car that can run on wood gas for a price as low as 500 yen (Rs. 400). The governments of all the above countries are giving considerable facilities to users of wood gas engines and vehicles by exempting taxes and giving special subsidies. The same could be done in India to make India more self-supporting as regards fuel for power and traction purposes.

Future in India.

There should be no difficulty in manufacturing either wood or charcoal gas producer equipment in India. Suitable fuelling stations could also be conveniently erected at points every eighty or hundred

miles along the trunk roads of the country. Villages could become self-contained for purposes of power production and illumination. There is undoubtedly a great future for wood and charcoal gas in India not only in obtaining a better value for agricultural, industrial and forest waste products, but also in reducing the great financial drain on the country from the importation of several crores of rupees worth of power and illuminating oil from abroad. It would also supply the Indian villager with a handy and inexpensive source of power, and would enable the Indian motor vehicle owner to run his lorries, buses, and cars at a fraction of the present cost, as one horse power can be obtained for an hour with only two pounds of wood.

THE CONTRIBUTION MADE BY AERIAL PHOTOGRAPHS IN ESTIMATING THE VOLUME OF STANDING TIMBER

SUMMARY.

After a short general introduction the present work describes the special conditions introduced by the use of aerial pictures in estimating the volume of standing timber in contrast to the usual ground methods.

The estimator's point of view is completely changed. Realization of this change is necessary so that when studying the aerial forest pictures subjectively, the new methods are not forced to conform to the old, but are used intelligently as a supplement to the old methods.

That which is essentially new in the method is practically, really something negative, namely, the inability to measure the diameters is offered by the easily measured crowns, using the well studied relation between crown and stem, particularly D. B. H. Recent studies of this sort with beech have proved that the correlation coefficient between crown and D. B. H. is on the average 0·80 ; that means that, theoretically, volumes may be obtained with sufficient accuracy from crown diameters, not only for stands but also for single trees.

By the complete renunciation of stem diameters, the aerial photograph shows an entirely new method, resting chiefly on the possibility of measuring the heights of stands accurately from the photographs.

The following chapter gives a systematic view of the new photogrammetrical methods of estimating the volume of standing timber.

The methods are divided into those which make no use of this relation between crown and stem and which may be named *Yield-Table Methods.* They are quite similar to corresponding ground methods but permit of certain improvements, as for example the determination of density of stocking.

The second method may be known as the *Growing-space Coefficient Method* and rests on the relation between crown diameter and D. B. H.

Two ways of employment are possible (*a*) the *General Volume Method* which corresponds to the ground form-factor method, and (*b*) the *Volume-Table Method* which corresponds to the ground method of the same name. By using the second, classes may be formed according to size of crowns or according to height. Lastly the automatic plotting of height profiles with the *Universal Mapping Machine* offers the possibility of determining the whole growing space, *i.e.*, the whole volume of the stand which is above ground, and herewith through reduction by means of density factor the estimate of volume is obtained almost automatically.

The following chapter deals with the technique of interpreting the aerial forest photos in so far as they are used in determining the volume of timber. The possibility of distinguishing individual tree species and the determination of relative mixture may be demonstrated with several stereo-pictures.

With regard to the " area " the most important factor as a basis not only of the standing volume estimation methods, but also for all other forestry, its assessment from the aerial photos in a Universal Mapping Machine is indicated.

The section dealing with stem count, density, and height determination, covers a large field and in the present work is limited to the species spruce. Next the results of a careful examination of stem

counts from aerial pictures are given, together with the *systematic* and *true* error. It is worth noting that in connection with the older stands (which are the only ones to be considered in determining volume) only trees with a D. B. H. of 10 cm. and more are distinguishable with any degree of accuracy.

The true error freed from *systematic* influences as determined from frequent counts is $\pm 6, 8\%$.

The density and corresponding number of stems which are easily determined from aerial photographs introduce an improvement by means of the proposal to obtain the volume from the relation between stem count and volume density. The result is a graphical table from which may be found in a simple manner the volume density of crop and the volume after determining the number of stems per ha.

A particularly important quality of the photogrammetrical method is the ease with which heights can be measured, especially the heights of stands, which can be plotted automatically, parallel to each other and at equal distances apart.

The possibility of measuring heights and crowns allows the formation of quality classes which classify the timber in the stand according to length and diameter.

After pointing out that simpler methods are necessary in the new conception of forest management, the next chapter deals with the special problems of aerial photography in the older countries. As an example several stands in the Revier Tharandt have been chosen for a volume estimate by the Yield-Table Method.

Compared with a control ground estimate of the same stands the total error for approximately 16,000 Cu. M. was $+0, 4\%$, and for the fifteen single stands variations showed a true error of $\pm 7, 4\%$.

After discussing the economic feasibility of the photogrammetrical estimate of volume which may be carried out with the regular management aerial survey, the chapter closes with the statement that it appears desirable that this work should be carried out in special centralized institutes.

The last chapter explains briefly the importance of photogrammetrical surveys in new countries and after discussing the choice and the peculiarities of the most suitable methods, an explanation of the technique of carrying out such a survey is given.

(Von der Sächsischen Technischen Hochschule zu Dresden zur Er langung der Wiirde eines Doktor-Ingenieures der Forstwiss enschaften genehmigte Dissertation.)

(*Beitrag zur Vorratsermittlung aus Luftmebbildern.*) Z.A. 29.

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for May, 1937:

IMPORTS

ARTICLES	MONTH OF MAY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER Teakwood— Siam ..	1	510	75	55	62,717	8,851
French Indo-China ..	15	296	65	1,747	29,189	6,427
Burma ..	..	..	12,641	..	..	15,61,902
Other countries ..	..	..	355	..	..	44,132
Total ..	16	806	13,136	1,802	91,906	16,21,312
Other than Teak— Softwoods ..	751	1,379	1,217	45,910	80,576	88,424
Matchwoods ..	..	997	714	..	55,313	40,795
Unspecified (value) ..	..	..	..	1,67,012	46,394	2,31,356
Firewood ..	26	36	127	394	540	1,903
Sandalwood ..	67	45	..	20,041	12,667	..
Total value of Wood and Timber ..	..	..	..	2,35,159	2,87,396	19,83,790
Manufactures of Wood and Timber— Furniture and cabinet-ware ..		No data.			No data.	
Plywood ..	..	221	428	..	55,747	1,00,093
Other manufactures of wood (value) ..	..	..	..	2,44,211	1,15,782	1,51,453
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,44,211	1,71,529	2,51,546
Other Products of Wood and Timber— Wood pulp (cwt.) ..	33,041	16,017	3,794	2,15,730	1,02,864	79,472

EXPORTS

ARTICLES	MONTH OF MAY					
	Quantity (Cubic Tons)			Value (Rupees)		
	1935	1936	1937	1935	1936	1937
Wood and Timber						
Teakwood—						
To United Kingdom ..	896	4,305	1	1,76,039	9,41,789	350
,, Germany ..	208	274	..	50,592	63,557	..
,, Iraq ..	50	45	20	12,713	6,486	4,532
,, Ceylon ..	146	174	..	20,232	19,083	..
,, Union of South Africa ..	429	483	..	71,344	96,513	..
,, Portuguese East Africa ..	29	138	..	4,780	24,827	..
,, United States of America ..	40	..	..	8,872	..	..
,, Other countries ..	567	290	41	85,276	62,926	12,527
Total ..	2,365	5,709	62	4,29,848	12,15,181	17,409
Teak keys (tons) ..	180	349	..	27,000	50,664	..
Hardwoods other than teak ..	23	140	..	2,300	15,777	..
Unspecified (value) ..	..	..	..	65,060	72,318	4,02,475
Firewood (tons) ..	13	..	..	175	..	..
Total ..	216	489	..	94,535	1,38,759	4,02,475
Sandalwood—						
To United Kingdom ..	10	1	1	12,060	1,000	1,800
,, Japan ..	5	..	..	5,600	..	..
,, United States of America ..	7	60	..	7,040	62,000	..
,, Other countries ..	20	45	54	25,457	55,383	57,330
Total ..	42	106	55	50,157	1,18,383	59,130
Total value of Wood and Timber ..	..	..	..	5,74,540	14,72,323	4,79,014
Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	4,683	10,576	19,303
Other Products of Wood and Timber ..	No data.			No data.		

INDIAN FORESTER

SEPTEMBER, 1937.

THE PROPAGATION OF SELECTED TYPES OF FOREST TREES

BY SIR GERALD TREVOR, I.F.S.

The importance of the proper selection of seed has received some attention in India during the past few years but even now insufficient attention is paid to the source of seed supply and the quality of the mother tree. Champion has dealt with the importance of geographical types in his article " The Importance of the Origin of Seed used in Forestry " (Indian Forest Records, Vol. XVII, Pt. V., 1933) and has summarised all the knowledge, both Indian and European, existing on this subject up to that date. As a result of discussion at the 1929 Silvicultural Conference an all-India teak seed investigation is being carried out in various parts of India and a comprehensive series of tests was also laid out at Dehra Dun. Unfortunately this latter experiment has been ruined by frost and has been abandoned. The chir pine (*Pinus longifolia*) and the sal plantations of the Forest Research Institute are all made from seed of different origins which have been duly recorded and in due course any inherent different racial characteristics should appear.

It is now well known that in the case of afforestation only geographical types corresponding to the climate (elevation, rainfall, maximum and minimum temperature, etc.) of the locality to be afforested should be used although there are exceptions to this general statement. For instance *Bambax* of Burma origin is hardier in Dehra Dun than the native type.

Apart, however, from some attention to geographical types and the selection of mother trees in natural regeneration, a matter insisted on in my Kulu working plan of 1919 and practised in Kulu since 1912, little attention has been paid to the propagation of improved strains

of forest trees in India. The time has now come when the propagation of the seed of specially selected type trees of the best form, straightest boles and greatest vigour, should be undertaken. It is quite easy to classify the sissu ***Dalbergia sissoo*** trees of the Punjab irrigated plantations into three form classes—1 good, 2 average and 3 bad. Some years ago I suggested doing this classification and collecting seed from class 1 and growing it separately. From the latest research report I gather that something has been done but I do not know whether this investigation has been placed on a proper scientific basis. Some particularly fine types of deodar are found, such as the Dungri and Pulga types in Kulu ; seed from individual selected trees of the best types should be collected and the plants put into special plantations for observation, the controls may be of ordinary commercial seed. Especially in the case of the blue pine (***Pinus excelsa***) can the superiority of certain trees as regards straightness of stem and narrowness of crown be observed as compared to the common much branched variety. These elite trees should be searched for, recorded, and their seed collected and specially grown. The same statement applies to the chir pine where we can select both for form, as in the Tons valley chir, or for resin yield. The seed of specially selected heavy resin-yielding pines is already being grown at Dehra Dun. What we do not know is whether resin yield is an inherited character and if so whether the character is transmitted by the male or the female parent. Only cross-hand pollination and patience over a long time can establish this—a great deal has been done towards increasing the yield of rubber by selection and vegetative reproduction. In the case of sal stem form is not so important as longevity and constitution. The greatest defect in our sal forests is unsoundness and if we bred from specially selected individual trees and make plantations for future seed supply from such selected sources some good might result. As pointed out, however, by Larsen in his admirable article on " The Employment of Species, Types and Individuals in Forestry," published in the 1937 Yearbook of the Royal Danish Veterinary and Agricultural College, the disadvantage of all this type of work lies in the fact that nearly all our forest trees are wind pollinated and in

consequence therefore only one parent is known to us. We may select the mothers but have no control of the fathers except in so far as all the parent trees are selected as in regeneration under the uniform system where the chances of outside pollen fertilizing the mothers can be considerably reduced. Hence the paramount importance so often insisted on by me of selecting only the best trees as mother trees in natural regeneration. By breeding from our specially selected mother trees and concentrating their offspring in definite plantations we should be able to develop the best possible local race. Larson, however, points out that all the improvements effected in agriculture and horticulture involve both artificial cross fertilization and vegetative reproduction. In our case the former presents great difficulties and considerable expense and is hardly practicable under present financial restrictions. The vegetative reproduction of our forest trees has, however, never received much attention. With conifers especially nothing has been done although it is known that deodar can be grown from cuttings. The age of our forest trees also militates against such investigations. In the case of *Dalbergia sissoo* these disadvantages do not apply. The tree grows quickly and matures seed at an early age. Individual trees can be propagated by root cuttings and it should be quite easy to raise a plantation of the best selected forms both from the seed of selected trees or from cuttings of one individual tree. The irrigated plantations of the Punjab offer a splendid field for the investigation of this subject. Admittedly the whole question of improving the races of our India forest trees by artificial selection is exceedingly difficult. The age of maturity of forest crops, the great difficulty of self and cross pollination and the uncertainty of the male parent and even of the pureness of race of the female all introduce so many unknowns as to render breeding on mendelian principles extraordinarily difficult. However, some progress is better than none, and I commend this problem to any silviculturist who has sufficient enthusiasm to pursue it.

REGENERATION OF FROST-LIABLE FORESTS IN THE CENTRAL PROVINCES

BY K. P. SAGREIYA, I.F.S.

Summary.—On the presumption that frost-bite in plants is caused when temperature of the surrounding cold air falls below a certain level, the writer suggests a method of preventing frost by inducing circulation of the stagnant cold air by cutting a series of strips across the frost-liable depression running in the direction of the prevailing wind in the locality.

The question of finding out a method of successfully regenerating or rather afforesting frost-liable areas, both in the teak and the sal forests has, of late, been engaging the serious attention of the forest officers of the Central Provinces. The latest experiment (and it is nothing more than this) is the prescription in the revised Melghat plan, where frost-liable areas are to be regenerated in one chain wide strips which run at right angles to the direction of the morning sun, and of widening these strips towards the sunny side at intervals of five years, *i.e.*, extending the fellings so that there is always a mature crop adjacent to the clear-felled strip and towards the SE which, roughly, is the direction of the morning sun in the winter.

Observations along firelines and roads running NE—SW, which is the prescribed direction in which the strips run, seem to indicate that these fellings against the morning sun are not likely to be of any avail. In other words the theory that the morning sun causes frost-bite does not seem to hold good. On the other hand it is quite likely that all the damage is done, not when the thawing takes place but perhaps long before that, some time at night, directly the temperature goes below a certain level, which may or may not be less than the freezing point of the cell-sap or even that of water, *viz.* 32°F. If this is the case, obviously the remedy lies in preventing the temperature from going down below this critical point at which the succulent plant tissues get chilled. In other words we should by some means avoid stagnation of cold air which causes this chilling. I am here talking with particular reference to the C. P. conditions where as a rule the temperature rarely drops down to freezing point over considerable tracts. Actually we get hoar-frost and not

freezing, and the areas over which this extends are never more than a few hundred acres.

I believe I have observed that generally the areas that get frosted are those where the air does not circulate freely on breezeless nights. I have also noticed that on comparatively level ground if a small patch is clear-felled or, say, a gap is caused by windbreak, with tall overwood all around, the young crop on the cleared island suffers from frost, whereas regeneration in the surround which is sheltered by the overwood escapes damage; or at any rate the damage is confined to the outskirts of the cleared patch.

If these observations are correct it would appear that if we could drain the pools of cold air in the frost hollows, we should avert frost damage. *Could we not drain away the stagnant cold air by cutting* a strip or a series of parallel strips at short intervals, right across the frost-liable depressions (which can be easily located) and running in the direction of the prevailing wind in the locality? Another thing that could be done to hasten the circulation of air will be to light a fire at the leeward end of the strips, when the hot rising air will act as a sort of suction pump.

I am anxious to know if such fellings have been tried anywhere, and if so with what result, or in the alternative if there is any flaw in my reasoning.

PROTECTION OF PROSOPIS JULIFLORA PODS FROM ATTACK BY CARYOBORUS GONAGRA

By C. L. Kapur, Forest Ranger, Punjab.

Its use as a shade tree and the utility of its pods for cattle fodder is responsible for the wide cultivation of *Prosopis juliflora* in its various forms. This species is propagated by seed, but the storage of pods is a great problem, because these are readily attacked by an insect *Caryoborus gonagra*. The development of the insect is probably due to the large amount of water and sugar in the pods, which make the ripe pod palatable for cattle. Some means of preventing insect

attack was therefore desirable and a few experiments were conducted in the Silvicultural Research Division, Lahore.

Insecticides commonly used are mercuric chloride, copper sulphate, lime, etc. Most of these are used in solutions. In the present investigations a solution could not be used, because the assimilation of certain salts such as mercuric chloride is known to be detrimental to the germinative power of the seed. We had, therefore, to confine ourselves to the use of insecticides which could be used in the solid state. In making this selection care was taken to choose the cheapest and least poisonous.

Slaked lime is the one that would naturally attract first attention, but after experimenting it was found to be of no help in solving the problem, *vide* appendix attached. Naphthalene pills and calcium carbide were later tried and the former was found to be a little less effective than the latter, *vide* appendix attached. Moreover, naphthalene balls being dearer could not be used on a large scale.

Further experiments to test the use of calcium carbide were carried out and the method evolved is given below:

Ripe pods of any form of *Prosopis juliflora,* free from the cuts and injuries of parrots, should be collected the very day these fall on the ground and stored preferably in tins of the size of a kerosene oil tin, with an air-tight lid. Daily the pods should be spread in the morning sun and stored again in tins in the evening and this should continue for at least 15 days, depending upon the quantity of moisture in the pods and intensity of the sun's heat. After every bit of the pod has been dried, ½ lb. of calcium carbide should be added into the tin in three layers amongst the pods and then the lid replaced very tightly.

The tin in no case is to be packed with the pods up to the top, but 2 inches of space must be left for the gas, which is produced by the decomposition of calcium carbide. The tins after having been packed with pods and calcium carbide must be stored in a dry place and the man working with calcium carbide should not have wet hands or have fire near him, otherwise he will burn his hands or cause an explosion.

APPENDIX.

Results of Experiments.

Quantity of insecticide.	Quantity of non-bored pods.	Duration.	Result.	Remarks.
Slaked lime 2 seers	4 seers	10 days	500 insects developed and had bored 52 per cent. pods.	These results are the averages of observations noted with pods of various forms of *Prosopis juliflora*.
Naphthalene pills 1 lb.	,,	20 ,,	49 insects developed and had bored 12 per cent. pods.	
Calcium carbide ½ lb.	,,	20 ,,	No development of the insects and pods remained as fresh as before.	

NOTE.—Calcium carbide is useful for fumigation, but why not follow the usual practice for food grain storage in the Punjab, *i.e.* in containers or bins closed above by a layer of ine sand.—C.F.C.B.

RESULTS OF SILVICULTURAL TREATMENT OF BAMBOOS IN THE HOSHIARPUR DIVISION

By I. D. Mahendru, P.F.S.

In September last I had an opportunity of looking at the Karanpur and Bindraban Forests of the Hoshiarpur Division in which silvicultural treatment of bamboos had been carried out since 1933-34. The treatment simply consists of cleanings combined with final fellings carried out as one operation in each individual clump.

The beneficial effects of this treatment are at once apparent; one need not look out for them, they are forcibly thrust on one's observation. The clump response is of a very characteristic type; the new culms are not only more numerous, but stouter than the old ones, measuring fully one to two classes higher in the scale of stoutness. The average production per clump has risen from 4 to 11 *manus* in the first year, and is 10 and 8 in the second and third year respectively.

Further, the results are better in the case of the more heavily worked clumps. This is well illustrated in the experimental area in Karanpur which was worked in 1933-34. Here the clumps were very congested and consisted of masses of tangled old culms, with *manu* production almost at a standstill. A reversal of the picture has been brought about by the treatment; the clumps are now open and made up mainly of 1 and 2-year culms, all due to heavy fellings which were necessary to get rid of the densely packed, over-mature and dead culms in the clumps.

The explanation which suggests itself is that the growth energy of the clump utilised by the old culms becomes liberated by this removal and available for the development of the new culms. This stimulating effect of the removal of old culms on the activity of the rhizome is analogous to that of pruning on the vigour of plants and might be better appreciated if it is remembered that old culms are to the root-stock what old branches are to the tree-stems, both are organs which have outlived their utility and are no longer required. Nature left alone would in time get rid of these in its own way; but the same or rather improved results can be brought about quickly by a carefully considered system of pruning of which the so-called silvicultural treatment is the equivalent.

Any one who has seen the results cannot but wish that this sort of treatment should be continued in the future. Rather one might like to go further in the matter of intensity of fellings. The present rules insist on the partial retention of old culms for support of new ones and to cover the clump area evenly. This would be all right when starting with unworked clumps, but quite unnecessary for clumps in the second felling cycle. With increased production of *manus*, there is likely to be no dearth of new culms to choose from for distribution over the clump area, and as for support, old culms, like old men, seem to need it more than those in their full vigour. In fact the need for " support " and the need for even distribution are just two phases of one and the same problem—given a sufficient number of new culms which can be evenly spaced out over the clump area, both the needs would be adequately met.

NOTE ON SANDAL GROWTH IN COORG

BY J. E. M. MITCHELL, CHIEF FOREST OFFICER, COORG.

In Coorg sandal is a royal tree but only 8 per cent. of the growth under sandal is found in Reserve Forests. The balance is found in coffee estates, lands granted for cultivation and unreserves. Of 92 per cent. about half exists in unreserves. Even up to the present date the Forest Department have no control over these sandal forests. In the past the outturn varied enormously from 200 to 500 tons per annum. When Mr. Robinson was Chief Forest Officer, Coorg, he thought it advisable to have a scheme prepared for the exploitation of sandal and an enumeration was conducted between 1924-26. Prior to this and going by figures of an enumeration done in 1922 it was estimated that there were 8,000 tons of sandal in Coorg. The enumeration done in Mr. Robinson's time estimated the growing stock as 4,000 tons. From 1926-1935 approximately 3,000 tons have been extracted and as the actual yield (which was from dead trees) fell considerably short of the estimated one, it was considered desirable, till we were in a position to know what the growing stock was, to conduct enumerations in unreserves which contained a good stock of sandal. In the forms attached, I have given extracts from the enumeration registers. The sandal in all these areas has never been under any protection and has been subjected to frequent fires and damage by the local villagers. In previous years all dead trees in such areas were extracted. So the figures now furnished do not reveal the true *facts as to the original number of trees found in such* areas.

Sandal is usually associated with the poor type of deciduous forests with a rainfall which varies between 30 to 40 inches. During my inspection of these forests in Coorg, I have found trees of 60 inches girth with a height of 70 feet approximately in semi-evergreen forest. However, one might say that such trees do not contain much heartwood. However, for many years, the number of sandal

trees which form one ton of heartwood has remained fairly constant, *i.e.*, 30 trees. Most of the sandal in Coorg is found in Somwarpet range and the rainfall varies from 45 to 100 inches. So the argument that trees found in rich soils do not contain as much heartwood as trees found in poorer soils seems to be open to argument. In most of these paisaries the sandal does not suffer from want of host plants, what it does suffer from, in my opinion, however, is that it gets no protection, nor has much attention been given to tending. I have only taken a few results at random from one of the enumeration registers and it is amazing that in spite of repeated fires, etc., so many trees have managed to survive over 15 inches girth. Either the regeneration is so profuse that quite a considerable percentage manage to survive to reach the 6 inches girth class or light ground fires might although not killing out the regeneration in all cases stimulate the growth.

It is considered possible by systematic tending of the best sandal areas and by taking precautions in the dry weather to develop the existing stock and also increase the stocking. While perusing the enumeration register the drop in the number of trees in the girth classes over 30 inches is most noticeable. It is difficult to account for this because there have been different systems of exploitation of sandal in the last 20 years and there is not sufficient data available to say how long it takes one girth class in one locality to pass into the next girth class.

On perusing data of some sandalwood Working Plans from Bombay, one would be inclined to take all possible measures to retain a tree till it was 45 inches. The heartwood put on from 30 to 45 inches is almost double but again no one knows how many years it takes to develop from 30 to 45 inches. During extraction I have seen many instances of trees over 30 inches which are hollow. This applies to both dead and green. Data of trees from different localities are now being collected and it might be considered desirable to cut green trees at a fixed girth instead of letting them get hollow or damaged by fire.

Girth.

Hanagallu Shettalli area, 216 *acres*—

18″	21″	24″	27″	30″	33″	36″	39″	42″	
No. of trees in each girth class :									Plants
83	75	47	37	15	9	5	2	1	293

Elevation—3,500 feet.

Rainfall—100 inches.

Hosts.—***Honne, Nandi, Eugenia, Jack, Ficus, Terminalia belerica,*** *Pongamia.*

Description.—Open jungle and parts of it semi-evergreen.

Hanagallu. 148/12—*area* 40 *acres*—

15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
141	144	122	80	48	22	19	9	6	1	2

Plants—1,147.

Locality factors same as for above village.

Note total number of green trees from 6 to 45 inches on 40 acres is 1,075 and 1,147 seedlings from ½ to 6 inches girth.

Kasalagode area, 475 *acres*—

15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
215	172	95	80	50	33	14	12	6	1	5

Plants—2,895.

Total trees enumerated from 6 to 45 inches—2,085.

Elevation—3,000 feet.

Rainfall—80 inches.

Aspect—West-East.
North-South.

Hosts—***Honne,*** Rosewood, ***Ficus, Nandi,*** Bamboos, ***Randia.***

East portion mostly open jungle and West is covered with lantana. Fires have done damage to regeneration.

Molathe Harohalli, area 136·38 *acres*—

15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
163	116	99	52	37	20	7	6	3	4	4

Plants—1,238.

Total trees enumerated from 6 to 45 inches—1,314.

Rainfall—70 inches.

Elevation—3,000 feet.

Aspect—West-East.

Host trees same as for Hanagallu.

Mulloor—area 161 *acres—*

6″	9″	12″	15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
582	447	372	329	223	122	55	37	16	9	6	5	3	1

Plants—2,387.

Trees enumerated	..	2,204
Plants	..	2,387
		4,591

Elevation—3,000 feet.

Rainfall—50 inches.

Aspect—West-East.

Soil—Loamy clay and rocky in places.

Hosts—*Honne, Matti,* ***Nandi, Ficus, Cassis fistula, Anogeissus latifolia***, Bamboo, Undergrowth, ***Randia***, lantana in some places.

The jungle is fairly open, but fires have done damage to young regeneration.

Kibbetta—area 272·0 *acres—*

6″	9″	12″	15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
741	604	495	365	207	153	87	38	22	15	2	2	..	5

Plants—2,204.

Total trees enumerated from 6 to 45 inches—2,734.

Rainfall—80 inches.

Elevation—3,000 feet.

Aspect—West-East.

Soil—Loamy clay.

Host plants—***Eugenia*, *Honne*, *Nandi***, Rosewood, Bamboo, ***Terminalia belerica*, *Randia***.

Forest fairly open. Lantana in patches.

NOTE.—Fires have done damage to young regeneration.

Kugoor—area 172·0 *acres*—

6″	9″	12″	15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
366	323	280	256	191	131	106	56	31	16	12	4	1	2

Plants under 6 feet—567.

Total trees enumerated—1,775.

Elevation—2,800 feet.

Rainfall—60 inches.

Aspect—East-West.

Host plants—*Terminalia tomentosa*, ***Nandi*, *Pterocarpus marsupium*, *Cassia fistula***, Bamboo, Undergrowth, ***Randia*, *Cipadessa*, *Zizyphus***, lantana found in patches.

There are no fires and very little grazing.

Sulimolthe—area 161·62 *acres*—

6″	9″	12″	15″	18″	21″	24″	27″	30″	33″	36″	39″	42″	45″
297	195	175	102	99	79	57	43	21	20	3	7	2	3

Total trees enumerated 1,103 and 979 plants.

RESULTS OF COPPICING, POLLARDING AND PRUNING EXPERIMENTS TO STIMULATE STRYCHNOS NUX-VOMICA FRUIT PRODUCTION

BY J. W. NICHOLSON, I.F.S.

Introduction.

Summary—(1) The yield of *kuchila* seed is proportionate to the size of the tree.
(2) Coppicing or pollarding trees reduces the size of the tree and causes a loss in seed production which is never likely to be made up. Pruning has the same effect but to a lesser degree.
(3) Coppicing very young trees may result ultimately in their acquiring crowns of fuller spread than if they were left to grow naturally, but trees tend to develop spreading crowns as soon as height growth starts falling off, artificial measures to promote crown spread are therefore not likely to be worthwhile.
(4) The yield of seed from individual trees fluctuates remarkably from year to year. Drought or fire, especially the latter, cause a subsequent drop in yield.

1. *Strychnos nux-vomica* (*kuchila*) is a common tree in the coastal tracts of Orissa. Its fruits have been a regular source of revenue in Puri division. In the south of that division it develops into a large handsome tree but it is not gregarious and the trees are usually surrounded by dense evergreen jungle and on this account and on account of scarcity of population fruit collection is not practicable. In the centre and north of the district it is a common tree in open dry deciduous or evergreen forests situated on sandstone or low level laterite. It is a reserved species and in the undemarcated protected forests, where unrestricted cutting of most species occurs, *kuchila* is now the commonest species left other than thorny species. In adjoining reserved forests where the canopy is denser it is comparatively rare. In these central and northern areas growth is slow and the tree never attains large proportions. Natural regeneration is found under fruit trees, such as mangoes, bats being the carrier agents of the fruits. The commonest method of reproduction is by coppice shoots and root suckers.

2. After the Great War the price of *kuchila* fruits increased enormously, the revenue from this source reaching Rs. 10,875 in the year 1921-22, 2,668 maunds being extracted. Early in 1923 Mr. Dodsworth, the Divisional Forest Officer, conceived the idea of attempting to stimulate fruit production by coppicing, pollarding and pruning *kuchila* trees. The experiment was taken over and

amplified by the Research Division in the following year. At the time of taking over the experiment it was noticed that a large number of *kuchila* trees were top dry and unhealthy. The original experiment was supplemented by an additional experiment to test whether coppicing back dying or unhealthy *kuchila* trees would prolong their lives and period of fruit production. The results of both these experiments are recorded below.

3. *Account of Investigation.*—In February-March 1923, Mr. Dodsworth selected an area, 2¼ acres in extent, in an undemarcated protected forest near Chandka and divided it into four sub-plots. In all the sub-plots the jungle was more or less completely cleared with the exception of *kuchila* trees. In " a " sub-plot the *kuchila* trees were pollarded at various heights ; in " b " sub-plot the *kuchila* trees were lightly pruned by cutting all twigs down to a diameter of about one inch ; in " c " sub-plot the *kuchila* trees were coppiced close to the ground ; in " d " sub-plot the *kuchila* trees were merely thinned out with the object of giving each tree plenty of crown space. In March 1924 the Research Officer thinned out *kuchila* trees in sub-plots " a " and " b " to make the conditions comparable with those in sub-plot " d." The trees left standing in these three sub-plots were serially numbered and their average diameters at breast height recorded, or below the point of pollarding if the latter was below breast height. In the case of trees which had formerly been coppiced or pollarded all shoots from the same stool were given the same number. Many of the trees in all sub-plots were of old coppice origin. No information was available as to the diameter and condition of trees before pollarding or coppicing in the preceding year. Instructions were issued that the amount of fruit produced annually by each tree in sub-plots " a," " b " and " d " should be weighed and recorded, and that in sub-plot " c " coppice shoots should be numbered as soon as big enough and their fruit production subsequently recorded.

4. In the supplementary experiment an area 1¼ acres in extent, adjoining the other plot, was selected. In this area 40 unhealthy trees either wholly dry or with dry tops were serially numbered and

the D. B. H. total height and condition of the trees recorded. 20 of the trees were coppiced. All other species standing in the plot were felled.

5. During the period 1925—1936 the yield of dry seed was recorded annually for each tree. The plots were fire protected and shrubs periodically cut back. In sub-plot " c " in 1926 the more vigorous stools were thinned out to two or three shoots per stool. In 1930 in the same sub-plot the trees were numbered and numbers 1 to 10 were pollarded at 4 feet from the ground to test whether this would produce trees with bushy and large crowns.

6. The details of the fruit yielded by sub-plots " a," " b " and " d " in the main experiment are given in the appended statements. The details of sub-plot " c " are not worth recording. Out of 115 trees, which had produced 320 shoots, one shoot from tree No. 8 (pollarded in 1930) yielded 1 tola of seed in 1935-36 ; two shoots from tree No. 63 yielded a total of 2½ tolas also in 1935-36 ; and one shoot from tree No. 87 yielded 1¼ tolas in 1933-34. Otherwise no fruit was produced. In 1936 the coppice shoots varied from 1 to 5 inches in diameter with an average of about 2½ inches. The shoots pollarded in 1930 had produced no bushier crowns than the unpollarded shoots.

7. In the second experiment the coppiced trees yielded no seed at all. The yield of seed from the uncoppiced trees is given in the statement appended. All the uncoppiced trees are now perfectly healthy.

8. The results from other than coppiced trees are summarised in the following table. In the case of trees which had more than one shoot the diameter class of the largest shoot has been taken for classification purposes.

Diameter class in inches.	AVERAGE PRODUCTION OF SEED IN TOLAS PER ANNUM OVER 12 YEARS.				
	Pollarded trees.	Pruned trees.	Untreated dry trees.	Untreated normal trees.	Remarks.
2—4 ..	·505	·701	1·458	1·277	* Only one tree.
4—6 ..	1·905	2·436	0*	12·191	
6—8	·132	17·125	..	33·600	
Over 8 ..	..	..	..	80·725	

9. *Discussion.*—Both experiments failed in their object. The growth of coppice or pollard shoots is so slow that after 12 years the trees which were treated are still producing a yield far lower than that of the untreated trees. The yield of seed is proportionate to the size of the tree. As the growth of coppice or pollard shoots only averages ·2 inches in diameter a year coppicing or pollarding merely causes the loss of many years growth. To a lesser extent pruning has had the same result. In no case have the crowns of the treated trees been improved although ultimately coppiced trees may produce larger crowns than uncoppiced trees—as the tendency for coppice or pollard shoots is to grow vertically rather than horizontally. Trees do not appear to acquire bushy crowns until the main height growth has nearly ceased.

10. The recovery of the apparently dying trees in the record experimental plot was unexpected. It appears that their dry condition was the result of a fire which had occurred in 1923. Although 1927-28 was a fairly good seed year no seed was produced by the dry trees until 1928-29 and only by one dry tree after that year. The average yield compares favourably with that of untreated trees in sub-plot " d " of the first plot owing to the good yield in 1928-29. This may have been a delayed after-effect of the fire but the figures are hardly conclusive.

11. The most interesting feature of the data collected is the amazing variation in yield from year to year and the failure of many trees to yield any seed at all. In sub-plot " d " six trees or 24 per cent. yielded no seed at all; in two years, 1924-25 and 1933-34, bumper seed crops were obtained; in three years, 1925-26, 1927-28 and 1935-36, fairly good seed crops occurred; of the remaining seven years, two yielded no crops at all and the rest very poor crops. In sub-plot " c " a bumper seed year occurred only in 1935-36, and in sub-plot " b " only in 1933-34. The only consistent feature in all sub-plots is the total failure to produce any seed crop in 1931-32—probably on account of climatic reasons, the summer of 1931 being exceptionally hot and dry.

FORM A.

Experimental Plot No. 1, Puri Division—Strychnos nux-vomica.

Statement showing the annual production of dry seeds.

Sub-plot " a "

Serial No. of tree.	D.B.H. or lower in inches.	Yield of dry seed in tolas in the years— 1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	6·7 ; 4·7	..	..	..	5¾	4½	..	..	..	..	1·5	..	..
2	4·2	..	..	..	..	..	..	..	..	..	..	..	..
3	3·8	..	..	..	..	..	..	..	..	..	..	..	..
4	2·3	..	..	..	..	..	2½	5	..	..	..	..	8
5	2·7	..	..	..	..	..	..	..	..	..	1	..	..
6	3·1	..	..	..	..		..	..	..	..	..	..	2
7	2·0 ; 1·7	..	..	..	..	..	..	..	..	..	..	..	..
8	3·1 ; 3·3	..	..	..	..		..	..	..	..	..	..	..
9	3·0	..	..	..	..	..	..	..	..	..	6	..	..
10	4·1 ; 6·5 ; 4·5 ; 5·5. 4·5	..	..	..	..	..	..	..	..	..	5	..	..

11	3·5	..	..	..	..	14¾	..	..	..	..	..	..	..
12	3·7	..	..	..	..	7	..	..	..	..	..	..	..
13	3·2	..	..	..	..	..	..	..	..	..	..	..	..
14	4·3	..	..	..	..	..	..	..	..	..	..	..	..
15	6·4 ; 6·5	..	..	..	..	..	..	..	..	..	..	..	..
16	2·8 ; 3·8	..	..	..	..	..	..	..	..	..		..	..
17	2·6	..	..	..	..	..	..	..	..	..	..	..	..
18	3·2 ; 3·1	..	..	..	..	..	..	..	..	..	..	..	..
19	5·1	..	..	..	..	..	..	..	..	..	..	..	..
20	3·0	..	..	..	..	..	..	..	..	..	..	..	..
21	2·6	..	..	..	..	..	..	..	..	..	..	..	..
22	4·6	..	..	..	..	..	..	10½	..	..	..	9	3½
23	2·6	..	..	..	..	..	..	..	..	..	..	..	..
24	2·7	..	..	..	..	..	..	3½	..	..	..	..	..
25	3·7 ; 3·2	..	..	..	..	3¼	..	..	..	..	..	..	..
26	3·9 ; 5·6	..	..	..	..	19	..	..	..	..	..	..	..
27	4·2	..	..	..	..	15	..	8	..	..	..	11	80
28	3·1	..	..	..	..	..	..	..	..	..		..	..
29	3·6	..	..	..	..	..	..	..	..	..	..	..	..
30	3·6	..	..	..	..	..	..	..	..	..	..	..	..
31	3·3 ; 3·5	..	..	..	..	..	..	..	..	..	..	..	..
32	6·7	..	..	..	1·1/8	..	..	..	..	..	..	..	2
33	3·5	..	..	..	..	..	..	..	..	..	..	..	..
34	2·1	..	..	..	..	..	..	3	..	..	..	14	80
35	3·5	..	..	..	..	..	..	..	..	..	..	..	..
	Total ..	0	0	0	7	64	3	30	0	0	14	34	176

FORM A.

EXPERIMENTAL PLOT NO. 1, PURI DIVISION—STRYCHNOS NUX-VOMICA.

Statement showing the annual production of dry seeds. (*Pruning.*)

Sub-plot "b."

Serial No. of tree.	D.B.H. in inches.	Yield of dry seed in tolas in the years—											
		1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	3·8	..	..	..	..	..	..	..	..	..	..	..	..
2	3·8; 4·9	..	1	..	6	7½	..	..	..	..	..	..	..
3	2·4; 1·6	..	..	..	..	6	..	..	..	..	1½	..	..
4	6·5	..	43	..	72	15½	..	..	..	..	75	..	..
5	3·1	..	..	..	..	..	..	..	..	..	2	..	..
6	3·3	..	..	..	..	..	..	..	..	..	8	..	..
7	4·8	..	..	..	..	..	..	..	..	..	..	..	..
8	3·6; 5·2	..	½	..	..	11½	..	..	..	..	8½	..	..
9	1·7; 1·4	..	..	..	..	..	..	..	..	..	..	..	..
10	2·0; 1·4	..	..	..	..	..	..	..	..	..	..	..	..
11	1·8	..	..	..	..	1½	..	..		..	..	..	..
12	2·1; 2·2	..	..	..	..	..	..	..	..	6	..	..	..

13	3·8 ; 4·6	..	..	..	½	..	..	..	..	8½	10	..	..
14	1·8 ; 1·8	..	..	..	..	..	..	..	..	5½	..	..	..
15	2·5 ; 2·7	..	..	..	..	..	..	..	..	..	..	..	..
16	3·0		..		..	..	..	..	..	..	..	..	..
17	5·6	..	..	..	..	8	..	..	..	..	..	..	..
18	5·5	..	..	..	⅓	⅓	..	..	..	..	40	..	..
19	4·3 ; 4·6 ; 4·1	..	..	..	4¾	..	..	..	..	..	..	..	..
20	1·9 ; 3·1	..	..	..	..	..	..	..	..	..	..	..	..
21	3·5	..	..	..	..	..	..	..	..	..	..	..	..
22	2·2	..	..	..	5¼	..	5	..	..	..	..	..	..
23	3·5	..	..	..	..	..	..	..	..	..	..	..	..
24	3·1 ; 3·9	..	..	..	..	..	..	..	..	..	..	..	..
25, 26	3·4, 3·7	..	..	..	..	88½	..	..	..	..	..	..	..
27, 28	3·1 ; 3·4, 3·7 ; 7·6	..	..	..	1¾	..	..	..	..	..	20	..	..
29	2·3	..	..	..	..	..	..	..	..	..	..	..	..
30	4·3	..	..	..	..	..	..	..	..	..	..	..	..
31	3·8	..	..	..	..	..	..	..	..	..	..	..	..
32	3·8	..	..	..	..	..	..	..	..	..	14	..	..
33	2·4	..	..	..	..	..	21½	..	..	..	..	..	..
34	5·2	..	½	..	..	..	27½	..	..	..	40	..	..
	Total	0	45	0	90	139	54	0	0	20	219	0	0

FORM A.

EXPERIMENTAL PLOT NO. 1, PURI DIVISION.

Statement showing the annual production of dry seeds.

Sub-plot "d." (*Thinnings.*)

Serial No. of tree.	D.B.H. in inches.	Yield of dry seeds in tolas in the years— 1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36
1	3·2 ; 4·5	..	..	..	..	..	..	..	..	..	..	..	..
2	3·2	..	..	..	..	..	..	..	..	..	..	..	..
3	2·8	..	..	..	..	..	..	..	..	..	60	..	..
4	2·9	..	11	..	10¾	9	..	..	..	..	2	..	5
5	3·4	..	..	..	..	..	..	..	..	..	..	..	..
6	3·7	..	..	..	..	..	..	..	..	..	6	..	..
7	4·9	1·0	3	..	1¼	..	..	..	..	26	80	8	80
8	4·4	..	..	..	..	..	..	..	..	..	19	..	..
9	3·5	..	..	..	..	..	..	..	..	..	..	..	..
10	4·2	..	..	..	1	..	..	..	..	..	10	5	2
11	3·7 ; 4·0 ; 3·9	..	..	..	..	3½	..	..	..	..	..	..	..
12	4·5 ; 4·6	2·5	4	..	54	..	..	..	..	..	35½	..	..
13	8·9	1,072·0	16	..	16	..	20	..	..	30	..	..	..
14	6·3	48·5	2	..	5½	..	7½	15	..	..	..	4	1½
15	6·4	..	78	..	40	10½	21½	6½	..	..	75	3	5
16	10·2	387·0	150	..	88	..	..	30	..	17½	5	14	192
17	8·0	..	90	..	26	..	..	..	..	26½	1,131	..	..
18	5·2 ; 4·5 ; 6·7	1·0	..	..	18¾	..	..	..	..	9	..	..	..
19	4·6 ; 5·1 ; 6·0	65·0	61	..	63	13	..	..	..	..	42½	..	..
20	6·3	416·0	10	..	92	..	..	6½	..	35	105	..	128
21	4·7	..	..	..	..	..	..	..	..	..	..	..	..
22	4·1	..	..	..	..	..	..	..	..	..	..	..	..
23	5·5	..	1	..	105	24	..	..	..	..	48	..	3
24	5·5 ; 5·1	..	14	..	99	27½	..	..	..	..	76	..	5
25	6·7	..	..	..	..	..	..	..	..	..	..	..	..
	Total ..	1,993	430	0	620	88	49	58	0	135	1,695	34	422

FORM A.

Experimental Plot No. 2, Puri Division—Strychnos nux-vomica.

Statement showing fruit production of uncoppiced trees.

Serial No. of tree.	Description in 1924.			Yield of dry seed in tolas in the year—												
	D.B.H. in inches.	Total height.	General condition.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	1935-36.	1936-37.
21	2·7	11	Whole tree nearly dry.	..		..	..	..	..	..	..	..	..	..	..	85
22	4·4	21		..	..	..	..	..	..	..	..	..	..	..	..	..
23	2·9	11		..	..	..	..	7	..	..	..	..	..	..	..	..
24	1·7	12		..	..	..	..	..	..	..	..	..	..	..	..	..
25	3·3	19		..	..	..	..	3½	..	..	..	..	..	..	..	..
26	3·3	17		..	..	..	..	3	..	..	..	..	..	..	..	..
27	3·6	21		..	..	..	..	35½	..	..	..	..	..	..	..	..
28	3·1	21		..	..	..	..	..	..	..	..	..	..	..	..	..
29	2·6	16		..	..	..	..	..	..	..	..	..	..	..	..	..
30	2·1	14		..	..	..	..	15	..	..	..	..	..	..	..	..
31	2·0	14		..	..	..	..	..	..	..	..	..	..	..	..	..
32	2·0	14		..	..	..	..	..	..	..	..	..	..	..	..	..
33	3·4 2·4	15 11		..	..	..	..	9	..	..	..	..	..	..	..	..
34	2·8	16		..	..	..	..	26	..	..	..	..	..	..	..	..
35	2·4	15		..	..	..	..	..	..	..	..	..	..	..	..	..
36	2·3	15		..	..	..	..	..	..	..	..	..	..	..	..	..
37	2·6	19		..	..	..	..	..	..	..	..	..	..	..	..	..
38	2·4	16		..	..	..	..	18¾	..	..	..	..	..	..	..	..
39	3·6	12		..	..	..	..	10½	..	..	..	..	..	..	..	..
40	2·9	12	Top dry	..	..	..	..	88	..	..	..	..	..	..	..	..

NOTE ON THE COMPARATIVE STRENGTHS OF SAPWOOD AND HEARTWOOD

BY H. TROTTER, I.F.S., UTILISATION OFFICER, F. R. I.

Summary—It shows that for all practical purposes the difference between the strengths of heartwood and sapwood is negligible.

At the Forest Utilisation Conference held at the Forest Research Institute, Dehra Dun, in March 1937, attention was drawn by some forest officers to the rejection in South India of treated hardwood sleepers containing sapwood, on the score that sapwood was considered by some railway officials to be weaker than heartwood. As the same question has been raised from time to time by other railway authorities, it was thought advisable to investigate the matter in the light of the information on the subject recorded from time to time at Dehra Dun when the testing of Indian woods has been in progress.

The intention of this note is, therefore, to clear up any doubts that may exist regarding the comparative strengths of sapwood and heartwood, more especially with reference to sleepers.

To start with, it may be noted that all restrictions regarding the amount or position of sapwood in conifer sleepers to be treated with a preservative were removed by the North Western Railway in 1930, and no reports about any mechanical weakness arising from treated sapwood have so far been recorded, despite the fact that some of the heaviest locomotives run on this line.

Experiments done in the Timber Testing laboratories at Dehra Dun and elsewhere have consistently shown that there is no appreciable difference in the strengths of sapwood and heartwood. The table reproduced on page 600 has been compiled from data recorded at Dehra Dun during the past 12 years or so. Although the figures are not very exhaustive, they do indicate decisively that, for all practical purposes, the difference between the strength of sapwood and heartwood is negligible, and that if there is any difference it is within the limits of variation allowed for a species. The table gives

the modulus of rupture in static bending, the compression perpendicular to grain, and the hardness for a few species from which it has been possible to obtain sufficient sapwood for testing purposes. It shows clearly that such differences as exist are insignificant.

In the case of some of the hardwood species, the sapwood shows slight inferiority in two of the properties that bear specially upon the suitability of a wood for sleeper work, namely, compression perpendicular to grain and hardness. This is possibly due to the infiltration of mineral salts into the heartwood, thereby causing it to become harder. But even in these cases, the strength of the sapwood, although less than that of the heartwood, is more than double that of other species like chir pine which is recognised as a good sleeper wood, and no fear of rail-cutting or under-cutting by ballast need be entertained.

Recently, some 50 sal sleepers out of a stock of 800 M. G. sleepers, specially cut from pole sal so as to include sapwood, were tested for hardness. The sleepers contained both heart and sapwood. The hardness figure for the heartwood was 1,540 lbs., while the sapwood figure was 1,310 lbs., a reduction of about 15 per cent., but the latter figure is still very much higher than the figures for pine and deodar, two woods which have been accepted for years as good sleeper woods.

It will be seen that in some strength functions the sapwood of some species has given better results than the heartwood, but, taken as a whole, it may be said that for all practical purposes the differences between the strengths of heartwood and sapwood are negligible, and there is no justification whatsoever for rejecting sapwood in so far as treated sleepers are concerned.

Serial No.	Species tested.	From	Condition at time of test.	Kind of wood.	Static bending modulus of rupture lbs. per sq. in.	Compression perpendicular to grain. Fibre stress at E. L. lbs. per sq. in.	Side hardness lbs.
1	*Dalbergia sissoo* (sissoo) ..	Dehra Dun, United Provinces.	Green ..	Heart ..	10,210	965	1,400
	,, ,, ,, ..	,, ,, ..	,, ..	*Sap* ..	*10,630*	*855*	*1,250*
2	*Dalbergia sissoo* (sissoo) ..	Hazaribagh (Bihar) ..	Green ..	Heart ..	10,960	1,360	1,560
	,, ,, ,, ..	,, ,, ..	,, ..	*Sap* ..	*11,735*	*1,355*	*1,445*
3	*Terminalia bialata* (white chuglam) ..	South Andaman ..	Green ..	Heart ..	10,880	845	945
	,, ,, ..	,, ..	,, ..	*Sap* ..	*11,420*	*1,045*	*1,080*
4	*Pinus longifolia* (chir) ..	Ranikhet, U. P. ..	Green ..	Heart ..	6,700	370	425
	,, ,, ..	,, ..	,, ..	*Sap* ..	*7,685*	*505*	*480*
5	*Terminalia tomentosa* (laurel) ..	Ramnagar, U. P. ..	Green ..	Heart ..	11,540	1,165	1,495
	,, ,, ..	,, ..	,, ..	*Sap* ..	*11,335*	*1,095*	*1,425*
6	*Pinus excelsa* (blue pine) ..	Rawalpindi (Punjab) ..	Green ..	Heart ..	5,915	..	..
	,, ,, ..	,, ..	,, ..	*Sap* ..	*4,905*	..	..
7	*Shorea robusta* (sal) ..	Dehra Dun, U. P. ..	Green ..	Heart ..	13,080	..	..
	,, ,, ..	,, ,, ..	,, ..	*Sap* ..	*11,330*	..	..
8	*Shorea robusta* (sal) ..	Dehra Dun, U. P. ..	Air-dry ..	Heart ..	19,380	1,975	..
	,, ,, ..	,, ,,	,, ..	*Sap* ..	*17,210*	*1,775*	..
9	*Shorea robusta* (sal) ..	Dehra Dun, U. P. Specially cut "sapwood" sleepers.	Green ..	Heart ..	..	..	1,540
	,, ,,	,, ..	,, ..	*Sap* ..	..	..	*1,315*
10	*Tectona grandis* (teak) ..	Hoshangabad, C. P. ..	Green ..	Heart ..	10,915	1,215	..
	,, ,, ..	,, ,, ..	,, ..	*Sap* ..	*10,585*	*1,060*	..
11	*Tectona grandis* (teak) ..	Hoshangabad, C. P. ..	Air-dry ..	Heart ..	14,405	2,135	..
	,, ,, ..	,, ,, ..	,,	*Sap* ..	*15,420*	*2,045*	..
12	*Dipterocarpus griffithii* (gurjan)	Insein, Burma ..	Green ..	Heart ..	..	750	1,075
	,, ,, ..	,, ..	,, ..	*Sap* ..	..	*655*	*920*

RESOLUTION ON ITEM 14.

The conference is of opinion that as a result of the experiments conducted by, and the experience gained at, the Forest Research Institute and similar other institutions abroad, the sapwood of most timbers can be taken for all practical purposes as equal in strength to the heartwood. It may also be recorded that the sapwood of practically all species can be treated with preservatives far easier than the heartwood. Therefore the Forest Research Institute should endeavour to have all restrictions that are at present imposed on the content or distribution of sapwood in treated railway sleepers and structural timbers removed.

MARMOTS

By Madan Pal, Forest Ranger, Chamba State.

If a traveller visiting Pangi cares to walk two miles up from Kilar village to a place called Paunsar nala which is at an elevation of 11,000 feet he will find himself among a colony of marmots.

In size this animal may be compared to a cat, but is very brilliantly coloured. The colour of the fur varies from yellow tawny to bright orange red with more or less black on the back, and the tip of the tail is sable. A black patch also surrounds the eyes but the rest of the face is brown while the under parts and legs are reddish brown. The full-grown animal generally measures about 3 feet long, and a specimen recently shot by me is 2 feet and 10 inches in length. The nose is rather arched and the upper lip cleft. The ears are rounded wide and their circular outline is fringed with hair. The tail is long and bushy and a few black hairs at the corners of the nose represent whiskers.

Like squirrels, there are five toes in the hind limbs but in the hands there are only four fingers, and the thumb is little more than a claw.

Marmots feed on grass and roots, and also lay in considerable stores of food during autumn for winter use. They excavate rounded long burrows with one entrance, ending in a sleeping place thickly padded with dry grass.

One of the marmots stands on its hind quarters and acts as a sentinel while his relatives are basking in the sun or running about actively in search of food. Whenever he spots any danger he warns his companions by means of a loud cry, and they at once resort to the doors of their burrows, and look round inquisitively to ascertain the business of the intruder. When any one tries to approach, he will see that when he gets within a certain distance all these little creatures will disappear suddenly with parting screams into their burrows.

In shooting marmots it is essential that they should be killed outright at the first shot, as otherwise they drag themselves down their burrows out of reach. After being fired at once and missed they will generally reappear after a short interval, but if again fired at they will remain underground for the rest of the day.

The young ones are born early in summer and are two to four in a litter. Though the fur is very beautifully coloured yet local people make no use of it. In Pangi low caste Hindus eat its flesh, and Bhuttia Hakims value the fat as a curative in rheumatic pains.

LARGE SAL TREE

By N. N. Sen, I.F.S., D.F.O., Ramnagar Forest Division, U.P.

The following scantlings were obtained from one sal tree in Narni compartment 7 during 1936-37. The total outturn seems to indicate that this sal tree beats the one of Assam which gave 142 M. G. sleepers :

Dimension of scantlings.		Number	Volume c. ft.
15′×11″×4″	..	1	4·6
15′×9″×4″	..	1	3·7
15′×8″×4″	..	3	10·0
15′×6″×4″	..	1	2·5
15′×6″×3″	..	1	1·9
15′×4″×4″	..	2	3·3
15′×4″×3″	..	6	7·5
14′×14″×5″	..	1	6·8

Dimension of scantling.		Number.	Volume c. ft.
14′×10″×4″	..	1	3·9
14′×9″×4″	..	4	14·0
14′×8″×4″	..	3	9·3
14″×6″×4″	..	1	2·3
14′×5″×4″	..	5	9·5
14′×4″×4″	..	21	32·6
14′×4″×3″	..	51	59·5
13′×8″×3″	..	1	2·1
10′×12″×4″	..	3	10·0
10′×10″×4″	..	1	2·8
10′×9″×4″	..	3	7·5
10′×8″×4″	..	6	13·2
10′×9″×3″	..	1	1·9
10′×7″×4″	..	1	1·9
10′×5″×4″	..	9	12·5
10′×4″×4″	..	2	2·2
10′×4″×3″	..	18	15·0
9′×14″×3″	..	1	2·6
9′×13″×3″	..	1	2·4
9′×10″×3″	..	1	1·9
9′×4″×4″	..	9	9·0
9′×5″×5″	..	1	0·9
8′×8″×4″	..	1	1·8
8′×4″×3″	..	2	1·4
7′×4″×3″	..	2	1·2
6′×4″×4″	..	1	0·7
5′×9″×4″	..	1	1·2
5′×4″×3″	..	1	0·4
4′×4″×3″	..	1	0·3
		Total ..	264·3

Two other sal trees in Narni block give 154·8 and 117·0 c.ft. of scantlings.

REVIEWS

A PRELIMINARY SURVEY OF THE FOREST TYPES OF INDIA AND BURMA.

Indian Forest Records—New Series, Vol. I, No. 1.

BY H. G. CHAMPION. *Price Rs.* 10-12-0 *or* 17*s.* 6*d.*

This is a pioneer book, the first attempt to draw up a standard classification of the forest types throughout India just as Schimper attempted to classify the types of vegetation throughout the world. The need for such a classification was urged at the Silvicultural Conference at Dehra Dun in 1929 with a view to co-ordinating the descriptions of types in working plans and letting writers of working plans know of other localities where types they were dealing with were to be found.

In his " Prefatory Note " the author writes: " The classification is published with the definite object of calling forth constructive criticism which will enable someone to revise and complete the much needed *survey as soon as possible*; *if it* succeeds in eliciting this criticism it will have served its purpose."

Most of us know some of the types he describes much more intimately than the author possibly can, but few foresters in India at the moment have had the opportunities he has of seeing nearly all the types he describes even if, in some cases, " only from the railway carriage window." He has given us the broad outline, which must necessarily be sketched in by a single hand, and has tentatively filled in the detail over the whole canvas as a cockshy for our criticism. It is now up to us to correct his mistakes in the types we know best so that a revised edition may appear as soon as possible.

The author has wisely limited his use of ecological jargon to the barest necessities and the book is intended for the ordinary forest officer. I wonder whether the ordinary forest officer will have as much difficulty as I had in finding his way about it. The lists of types by provinces given on pp. 275—280 should enable him to

decide the type he is camped in, but it is not easy to find out on what page to look for the description, etc., as a satisfactory index is practically impossible for such descriptive titles.

This one serious fault I have to find with the book might cause it to be less used than it ought to be, and could easily be remedied by giving page references against the *types* on pp. 18—23 and 275—280*. Page headings would also have contributed towards easy reference but in this the author had no doubt to conform to the standard of the series. To be told the name of the series, volume and number as well as the title of the book one is reading at the head of every page might at first sight seem unnecessary, but it is useful when a volume falls to pieces and the paper binding is quite inadequate for one of this size (and price).

I have noticed a few misprints but none likely to cause real confusion though the letterpress in my copy is disfigured by some blurred type, smudges and ragged alignment. The sub-tropical types have been omitted from the lists of types by provinces on pp. 275—280*. Northern moist bamboo brake is shown on p. 277 as one of the *types* found in the C. P. but this locality is not mentioned in the description of the *type* on p. 98.

I am not dealing here with what I believe to be mistakes in the subject matter of the book. Such suggestions for amendments must be cleared up by correspondence with the author and I hope that others will take a hand at this, for every forester in India is a potential critic of this work and the more the criticism the better for the next edition.

The two coloured maps show the distribution of climatic types and of rainfall. One has been placed at the beginning and one at the end of the volume so that both should be visible when it is spread out on a table—an excellent idea frustrated by the press which has printed one of the maps at the wrong end of its strip. The rainfall map, in the usual shades of blue, is excellent but the other would

* I understand that a revised copy of pp. 275—280 is being issued shortly giving these essential page ref. rences and remedying the omissions referred to.

have been clearer (and cheaper) if the artist had resisted the temptation offered by the three-colour process to exploit a wide range of mixed washes (which the colour printers have reproduced most skilfully and in good register in my copy) and used hatchings and stippling more. With red, blue and black at his disposal (I wonder when map makers will realize that maps are sometimes used by artificial light and avoid yellow—including of course greens and oranges) he could have represented his 15 types with ease ; as it is, there is precious little difference between Nos. 2 and 6 even by daylight. A minor inaccuracy in this map is that the sub-himalayan sal-belt is shown to end eastwards about the Tista river except for a small patch which seems to be somewhere in the south of the Nowgong District of Assam.

The forty plates, beautifully reproduced over a pale blue wash, are not only works of art but give a really good idea of the types they illustrate, at least in so far as I am in a position to judge.

The author is to be congratulated on the thorough and scientific way he has carried out the very heavy task allotted to him.

In conclusion I will repeat myself once again to urge all who know Indian forests to get this book out of the nearest forest library and supply the constructive criticism for which the author asks.

E. O. S.

A STUDY OF THE SOIL PROFILES OF THE PUNJAB PLAINS WITH REFERENCE TO THEIR NATURAL FLORA

By R. C. Hoon, M.Sc., and M. L. Metha, B.Sc., L.Ag.

(*Punjab Irrigation Research Institute Publication III*-3, August 1936, Superintendent, Government Printing, Lahore. Rs. 1-3-0.)

A most interesting and practical application of ecological principles has been attempted by the Irrigation Research staff in making use of the common trees of the arid *rakh* jungle to classify the land in terms of its potential value under irrigated farm crops. Soil analysis of samples taken from various types of ground showed

that the four commonest *rakh* tree species were each associated with a quite characteristic soil. Thus *jand* (*Prosopis spicigera*) and *van* (*Salvadora oleoides*) both indicate good soils for crops, but the latter being associated with rather coarser sand means that *van* soils are likely to suffer more readily when water supply is short. The *frash* or *okan* (*Tamarix articulata*) and *karil* (*Capparis aphylla*), on the other hand, indicate poor soils, the *frash* being associated with too much soluble salt and the *karil* with salt plus the presence of soil horizons which impede water movement, thus making the alkalinity more intractable and more permanent.

A fifth vegetation type was chosen, namely *Eleusine aegyptica*, a common creeping grass of arid ground locally known as *makra* or *madhana*, also often found as a weed of fallow fields. The analyses showed, however, that this grass indicates a much wider range of soil conditions than any of the four trees do, consequently the grass cannot be considered as a reliable indicator of soil quality. It would be exceedingly interesting if this study could be extended to others of the semi-desert grasses, such as *Eleusine flagellifera* (*chimbar*), *Andropogon annulatus* (*palwan* or *janewa*), and *Panicum colonum* (*swank*), all of which appear to have a more restricted habitat than the one chosen.

This paper contains full analyses of the work done and in addition a number of observations and comments on the soil profiles. In the case of *jand*, for instance, the soluble salt content may be so high that leaching with irrigation may be advisable before trying farm crops where *jand* has been felled. *Jand* is often associated with a fairly deep-set layer of hard nodular *kankar* which may become impermeable and form an artificial water table. The paper should be in the hands of all forest officers who have anything directly to do with irrigation work or any professional interest in the practical application of ecological theory.

R. M. G.

EXTRACTS

BETTER UTILIZATION OF FORESTS

The programme of the Frontier Ministry for the better management and utilization of the forests and waste lands of the Province with a view to improve the economic condition of the rural population is as follows :

It is pointed out that the presence of forests is a matter of extreme importance for the health and welfare not only of the present but the future generations of villages in the areas through which water can flow from the hills on which the forests are situated. While realising that this will in some cases conflict with the narrower interests of the dwellers near the forests, to whom the grant of unrestricted concessions would result only in the destruction of the forests, the Ministry will endeavour to make restrictions as little

hardship to the local people as possible. And in this they will be guided fully by the recommendations (most of which have been accepted by the Local Government) of the Hazara Forest Enquiry Committee which was appointed in 1933 to enquire into the grievances of the residents of Hazara regarding forest policy in that district.

IMPORTED FUEL.

The Ministry view with alarm the enormous amount that is at present being paid for fuel imported in the Province and will do all in its powers to gradually restore the forest wealth by reserving and bringing under management any forest areas that can be devoted to the production of firewood.

While giving every support to the Forest Department in protecting a valuable asset from illicit depredations, the Ministry will demand from them a high standard of service to the public and will lose no opportunity of removing grounds of legitimate complaint.

" GUZARA " FORESTS.

In regard to the " Guzara " forests, the programme says that their maintenance is a matter of vital importance to the people of Hazara District and it will be the constant endeavour of the Ministry to improve their management so that after providing for the requirements of the individual villagers the " Guzaras " may be worked for the welfare of the village community as a whole and not only for the benefit of the fortunate few.

WASTE LANDS.

Touching on waste lands the programme says that in accordance *with the recommendations of the Cattle Conference recently convened* in Simla by his Excellency the Viceroy, the Ministry will give their serious consideration to the development of the fodder resources of the Province. In the Frontier Province there are many thousands of square miles of waste land which, with proper management, could support a much larger number of cattle ; and the Ministry is of opinion that there are few better ways of improving the economic condition of the rural population than by assisting them to increase the fodder productivity of their extensive waste lands. With this object in view

the Ministry intend to tackle the problem by undertaking a rough survey of all uncultivated land which is potentially capable of producing fodder.—*A.P.I.*

SCOPE FOR THE FORESTRY PROFESSION

Charles Kingsley has remarked that " we act as though comfort and luxury were the chief requirements of life when all that we need to make us really happy is something to be enthusiastic about."

This being so—and I am firmly convinced that it is—what class of people should be happier than those engaged in the profession of forestry !

Where can you find higher ideals ? Where are there greater opportunities for observation, investigation, development and service ?

In what profession are the problems to be solved more diverse, the phase of influence wider and results more lasting ?

What profession is less unselfish in its aims and aspirations ?

Truly the forester has such a wide field for the development of enthusiasm that he never needs lack for an outlet for his energy or a field for profitable, entertaining and enlightening work.

The field for enthusiasm is unlimited.

The man who centres his thought on tangible materialistic income is never happy.—(*The Makiling Echo*, July 1936.)

NEW TANNERS' FEDERATION

The latest industry to organise itself in this country is the Indian tanning industry, which has recently formed an Indian Tanners' Federation under the presidentship of Mr. A. L. Carnegie, Managing Director of Messrs. Cooper Allen & Co. of Cawnpore. A conference was held at the end of July, and apart from the President there were present Mr. P. S. Pandit of the Western India Tanneries, Bombay, Mr. D. A. Randall of the Chrome Leather Company, Chromepet, South India, and Mr. B. M. Das of the National Tanneries, Calcutta. As a result of the deliberations a Federation was formed and it is

understood that it now includes in its membership a number of large firms in India which are interested in the tanning industry. The headquarters of the Federation are in Cawnpore and Mr. H. W. Morgan, Secretary of the Upper India Chamber of Commerce, will act as Secretary to the Federation, whilst the object of the body is permanently to watch the interests of the industry. Its immediate object will be to urge upon the Government of India the desirability of securing a continuance of the favourable terms which the Indian tanning industry secured through the Ottawa Agreement. Indian finished Chrome leathers were accorded a considerable preference at Ottawa and the possibility of that preference being withdrawn is causing a considerable amount of alarm amongst tanners in this country. Chrome tanning is one of a number of industries that will suffer heavily as a result of the ignorance of economic facts and the political impulsiveness that characterised the last Assembly, when they decided to give notice of termination of the Ottawa Pact. We have said that the industry will suffer considerably. We should add that it is not yet too late to retrieve the position, with another agreement.—(*Capital*, 3rd September 1936.)

PROBLEMS OF THE PAPER INDUSTRY IN INDIA

BY M. P. BHARGAVA,

(Forest Research Institute, Dehra Dun.)

The total annual consumption of all kinds of papers and boards in India in 1935-36 was 216,356 tons, as compared with 115,636 tons in 1925-26. In one decade, therefore, the annual consumption rose by about 188 per cent. The attached tabular statement summarises, under the main headings adopted in the trade returns, the quantities of the various kinds of papers and boards made in this country and those imported from abroad in the two years 1925-26 and 1935-36.

An examination of the table brings out the following interesting facts :

(1) That the production of Indian mills in the past has been confined mainly to writing and printing papers. *In 1935-36, these*

mills supplied almost 65 per cent. of the country's requirements of these papers.

(2) That the annual consumption of news-prints (papers for printing newspapers) increased from 13,672 tons in 1925-26 to 34,328 tons in 1935-36, *i.e.*, by nearly 251 per cent. This type of paper is not produced in India at all at present.

(3) That the total yearly consumption of packing and wrapping papers, including kraft papers, increased from 37,073 tons in 1925-26 to 77,857 tons in 1935-36, *i.e.*, by about 210 per cent. The whole of the above tonnage is imported from abroad and about 3/4 of it consists of printed unused newspapers.

(4) That the annual consumption of straw-boards, cardboards, etc., increased from 13,191 tons in 1925-26 to 28,175 tons in 1935-36, *i.e.*, by about 221 per cent. The share of the Indian production of these in 1935-36 was about 4,000 tons, or only about 14 per cent. of the total.

(5) That while the Indian production in 1935-36 was 176 per cent. of that in 1925-26, it was only 23 per cent. of the total consumption in 1935-36, as compared with 24·4 per cent. in 1925-26.

In view of the enormous forest wealth of the country, which can be utilised for paper making and of the " protection " extended to the industry by Government since 1925, the dependence of the country to such a large extent on foreign imports would appear to be rather anomalous. In the following paragraphs, the problems which face the industry to-day and which require to be solved in order to enable it to develop to its full stature, are briefly examined. For the sake of clarity and convenience almost the entire field of the consumption of papers and boards is scanned under the following main groups :

1. Writing and printing papers (better and medium qualities).
2. Cheap printing papers including newsprints.
3. Packing and wrapping papers including kraft papers.
4. Straw-boards, card-boards, paste-boards, etc.

1. Writing and Printing Papers.

It will be seen from the table that the production of these papers by the Indian mills increased in one decade from 25,203 tons in 1925-26 to 43,530 tons in 1935-36. The increased output was rendered

possible entirely as a result of the successful investigations by the Forest Research Institute and the Indian paper mills on the production of chemical pulp from bamboos. Prior to 1925, the industry depended mainly on *sabai* or *bhabar* grass (*Ischoemum angustifolium*) as its staple raw material. The available quantities of this grass were not adequate to permit expansion of the industry on an economic basis. In bamboo the industry has found a material, sustained supplies of which are available in abundance in different parts of the country and from which a large variety of writing and printing papers can be produced at an economic cost. The use of bamboo has enabled the industry, with the aid of " protection " granted by Government, to expand and capture almost the entire increase, in the last decade, in the demand of writing and printing papers, which would otherwise have been met by foreign imports. It is true that over 12,000 tons of writing and printing papers, consisting of superior quality and special papers, *e.g.*, banks, bonds, art, litho, etc., are still imported into the country. These papers could be made from bamboo and other available raw materials, but as the quantity of each individual variety is too small, its manufacture cannot be taken up profitably by an Indian mill, particularly as the distribution of such manufactures over the vast area of India would be uneconomic. Until, therefore, the demand for the individual papers increases considerably, their manufacture in this country is likely to remain uneconomic. Excepting these papers, therefore, India is now in a position to meet not only her present requirements of writing and printing papers but also to supply the greatly increased demands of the future. To enable her, however, to retain possession of this market, it is essential that research on bamboo, which has already put the industry on its legs, should continue, so that, in due course, the bamboo paper industry can successfully compete, without the aid of " protection" with the long-established and highly advanced wood pulp industry of the West, in which extensive research is still in progress in full vigour. Investigations to this end and with a view to improve continually the technique and lower the cost of production, form an important part of the programme of work of the Paper Pulp Section at the Forest Research Institute at Dehra Dun.

2. CHEAP PRINTING PAPERS INCLUDING NEWSPRINTS.

The consumption of these papers increased from about 24,000 tons in 1925-26 to about 46,000 tons in 1935-36, *i.e.*, by about 190 per cent. With the advent of the Reforms and the spread of education among the masses the consumption of these papers is bound to increase at a much higher rate in the coming years. It has not yet been possible to manufacture these papers at competitive prices in this country, as in their production a large proportion (70 per cent.—80 per cent.) of cheap mechanical pulp (*i.e.*, pulp made by mechanical processes of grinding without the use of any chemicals) are required, and the production of this kind of pulp from indigenous materials has not hitherto been attempted. The use of foreign mechanical pulp for the manufacture of these papers has not been feasible on account of the heavy protective import duty. Cheap mechanical pulp must, therefore, be made available to the paper-maker in this country in order to enable him to capture the large and growing market for these papers. The Forest Research Institute has already taken this problem in hand. The erection of suitable machinery for carrying out the experimental work is nearing completion and a systematic investigation on the possibility of using bamboos and woods for the production of mechanical pulp is in train.

3. PACKING AND WRAPPING PAPERS INCLUDING KRAFT PAPERS.

The use of kraft paper (strong brown paper used for packing purposes, often glazed on one side and rough on the other) on a large scale has only developed in India within the last few years. In 1935-36 the imports of these papers were 9,544 tons. As the use of this paper is likely to grow considerably in the near future, its manufacture in the country offers bright prospects. Recently experiments have been carried out at the Forest Research Institute on the production of kraft paper from bamboos, the only raw material which is at present available in sufficiency for the purpose. The results obtained are very promising and it is hoped that the investigations, when completed, may establish the possibility of producing satisfactory

qualities of kraft papers from bamboos and that their manufacture will soon be taken up in the country.

A remarkable feature regarding the other cheaper varieties of wrapping and packing papers is the enormous consumption of imported old newspapers. In 1935-36, while the import of ordinary wrapping papers was 10,730 tons, that of old newspapers was 57,583 tons or more than double what it was in 1925-26. These old newspapers are, as is well known, largely used for wrapping foodstuffs, fruits, provisions, etc., in bazaars. Such a use is admittedly very unhygienic and detrimental to public health. The price at which the old newspapers are dumped into the country is so low that it is impossible to manufacture any paper, even from the cheapest material available, to compete with them. In the interests of public health and of the development of a large and new industry it is obviously necessary that the present undesirable use of old newspapers should be discontinued. The only effective measures which can be taken to bring this about are: Firstly, the production of very cheap wrapping papers in the country. For this purpose it is indispensable that cheap pulp, both chemical and mechanical, should be available to the paper-maker. As has been mentioned above, investigations are in progress at the Forest Research Institute to cheapen the cost of production of chemical pulp, and experiments have already been initiated to explore the possibilities of mechanical pulp from indigenous materials. It is hoped that success will attend these investigations and that the manufacture of cheap wrapping papers will become economically possible in the near future. Secondly, it will be necessary to educate public opinion against the use of old newspapers for wrapping up foodstuffs, and lastly it may be found advisable to put a heavy protective duty on the imports of old newspapers, once the possibility of producing cheap wrapping papers in India is fully established.

4. STRAW-BOARDS, CARD-BOARDS, INSULATION-BOARDS, ETC.

The consumption of boards has more than doubled in the decade ending 1935-36. The Indian production of these products is barely 14 per cent. of the total demand. The smallness of the aggregate

demand, and the non-availability of cheap materials such as mechanical pulp or agricultural wastes have principally been responsible for the very slow growth in the manufacture of these products in the country. The phenomenal growth of the sugar industry in the last few years has, however, raised the problem of profitably disposing of surplus bagasse (crushed sugarcane). The Imperial Council of Agricultural Research has recently made a grant to the Forest Research Institute for investigating the possibility of utilising bagasse for the production of wrapping papers, insulation-boards, straw-boards, etc. These investigations are on the point of being started. The availability of mechanical pulp and the utilization of agricultural wastes will, it is hoped, render practicable the establishment of a board manufacturing industry in India, particularly as with the industrial and commercial development of the country, the demand for boards of various kinds is likely to become large enough to enable their manufacture to be taken up on a profitable basis.

To sum up, during the last ten years the consumption of papers and boards in India has increased on the average by about 10,000 tons per annum. With the industrial and economic development of the country and the widespread diffusion of literacy among the masses, the demand for papers, particularly of the cheaper variety, is bound to increase more rapidly in the future. The present *per capita* consumption of paper in this country is hardly 1¼ lbs. as compared with 150 lbs. in the United States of America, and is the lowest of all countries in the world, except perhaps China. There is thus an enormous scope for the growth and development of the paper industry in India. A well-organised plan, enterprise and sustained and intensive research are needed to exploit the natural resources and render the country self-sufficient with regard to her requirements of a commodity of vital importance for national development and for the progress of civilisation. Investigations on subjects of immediate industrial importance are, as has been shown above, in progress at the Forest Research Institute. If some other technical institutions and universities in this country, where facilities for applied chemical research exist, also interest themselves in problems

connected with these subjects and work in liaison and co-operation with the Forest Research Institute, it would help towards the sound and more rapid progress of one of the major industries of the country. The industry at present employs more than 6,000 hands and the total value of its imports amount to about 3 crores of rupees. If the major portion of these imports is manufactured in India, employment would become available to a considerably greater number of people, and the natural resources of the country would be utilised to the fullest advantage.

Item No.	Description of Papers and Boards.	Imports, Tons.		Made in India, Tons.		Total consumption, Tons.	
		1925-26	1935-36	1925-26	1935-36	1925-26	1935-36
1	Writings and Printings including *badami*, envelopes, etc.—						
	(*a*) Protected ..	8,637	12,095				
	(*b*) Not protected (**mostly** printing papers) ..	10,490	11,654				
		19,127	23,749	25,203	43,530	44,330	67,279
2	Newsprints ..	13,672	34,328	..	..	13,672	34,328
3	Kraft ..	..	9,544	..	..	..	9,544
4	Packings and wrappings	8,805	10,730	Included in item No. 6		8,805	10,730
5	Old newspapers	28,268	57,583	..	..	28,268	57,583
6	Other kinds	2,382	3,846	3,018	2,181	5,400	6,027
7	Paper manufactures ..	1,442	2,019	..	..	1,442	2,019
8	Straw-boards ..	10,933	15,090	..	4,000 (approximate figure)	10,933	19,090
9	Card-boards, Mill-boards, Paste-boards, etc. ..	2,258	9,085	..	..	2,258	9,085
10	Manufacture of boards	528	671	..	..	528	671
	Total	87,415	166,645	28,221	49,711	115.636	216,356

(*Current Science*, April 1937.)

PRUNING

Summary.

1. The increment of pruned trees is not, or only to a small extent, influenced by dry pruning and this influence is favourable, while green pruning usually diminishes the increment. Only trees *growing in the open tolerate* heavy green pruning without suffering any loss in increment. The removal of more than two-thirds of the crown leads to the death of conifers.

Diameter increment is decreased by green pruning to a certain extent, depending on the intensity of the treatment. Only when the pruning is very light and *limited to the removal of suppressed* branches with shade leaves does the increment increase somewhat.

The form of the tree is changed considerably by green pruning, that is, its amount of clear bole is increased. The width of the annual rings decreases in the lower portion of the stem just as it increases in its upper portion and crown.

The height increment of conifers remains the same after pruning or decreases. In the case of young oaks the height increment is greatly increased by green pruning.

The changes in increment values are most pronounced during the first or second year after pruning. With increasing foliage, the changes in increment resulting from pruning becomes less intense.

2. Heavy green pruning forces hardwood and larch to form watershoots. The formation of watershoots may make the results of pruning doubtful. In the case of the oak, the avoidance of watershoot formation after pruning and pruning the watershoots is the most difficult question connected with pruning.

3. On soil and dominant stand pruning acts in the same way as a *light thinning. An undergrowth of tolerent tree species under a* light crowned upper story is assisted by pruning the latter. The stems of the lower story of a spruce stand, however, die off after pruning the dominant stand.

4. Pruning in stands where the bark may be damaged is only possible when the pruned stands are effectively protected at the same time.

CONCLUSION.

In order to avoid considerable loss in increment and the extremely troublesome formation of watershoots, green pruning must be limited to a careful removal of a few lower crown branches.

Young oaks (perhaps other hardwoods, too) may gain in height through green pruning.

Pruned stems on endangered sites must be protected against injuries from game.—(*Dr. Hans Mayer-Wegelin*—Division of Silvics, *United States Forest Service, Translation No. 264, August 1936.)*

WOOD REPLACES STEEL

So much has been heard in the past about steel replacing wood for doors, furniture and other uses, that it is refreshing to learn of the great success which has attended the pioneering effort of Unit Structure, Inc., of Peshtigo, Wis., in making glued-up wood roof arches to take the place of steel arches. These graceful arch units lend themselves readily to interior designs which harmonize with modern architecture. This field of use is varied ; it includes churches, community halls, gymnasiums, dance halls, car barns and factories.

These structures are composite timbers made up by the correct arrangement of laminations united with waterproof glue under high pressure. The surfaces of the laminations are carefully surfaced, then even coatings of glue are applied and they are placed in specially-designed presses. Applied pressure forcibly curves the members into desired shapes, producing uniform joints throughout. The final product is, and has the appearance of, one solid piece of wood, with the cross-section distributed in such a way as is most desired from the standpoint of loads and stresses.

Here are reasons advanced in favour of wood arches :

Great fire resistance resulting from the use of a solid section instead of many scattered members exposing large surfaces.

High earthquake safety through elimination of dangers existing in made-up roof supports where collapse of entire structure may result from failure of one of many structural elements.

Easy erection because delivered in one piece; no expensive equipment or trained crew required.

High rigidity through the absence of bolted connections; the arches and their columns are one frame, eliminating load-bearing pilasters.

Pleasing appearance resulting from the natural beauty of wood plus the absence of unsightly network.

This example of wood replacing steel should speed up the search for other opportunities to increase the use of wood products and recapture lost markets.

The following comparison of the behaviour of wood and steel under fire will help to resolve that particular phase of the wood *vs.* steel argument.

Wood does not lose in strength when exposed to heat. Steel weakens under heat, losing its strength at 700 degs. F. Since ordinary fires reach temperatures of 2,000 degs. F., steel structures collapse at early stages of the fire.

Wood eliminates the hazards due to expansion, since its thermal conductivity is 1/200 that of steel and its coefficient of expansion only 1/10 that of steel. Steel is a good conductor of heat, therefore will readily distribute high temperatures, which in combination with its high coefficient of expansion will cause a considerable increase in its length. In case of steel trusses, side walls often are bulged out, causing complete destruction of the building and great damage to its contents.

Wood, as fires have repeatedly shown, was still in a position to act as a support after its section was reduced to one-third of its original size. The possibility of sudden collapse is eliminated. Steel collapses quickly. Flash fires have caused total failure of such structures. Extra expense in clearing away the tangled mass of wreckage adds to the already sustained loss. The " Casco Idea."—(*The Wood-Worker*, April 1937.)

POLYPORES AS ENEMIES OF TREES, TIMBERS, BUILDINGS AND AUTOMOBILES

BY S. R. BOSE,

Professor of Botany, Carmichael Medical College, Calcutta.

Polypores belong to the "Basidiomycetes" fungi which cause the greatest damage to trees, timbers, buildings, automobiles, etc. They are called *Polypores* because they have many pores or openings on the lower surface for liberation of "spores." All fungi are devoid of green colouring matter, chlorophyll, by means of which the higher plants can manufacture their own food. Hence, the absence of chlorophyll makes them totally dependent structures, either depending on living plants for their food-supply when they are known as parasites or on dead plant-products when they are known as saprophytes. The majority of *Polypores* are saprophytes but a good many have been found to be parasites, chiefly wound-parasites, entering a living tree through an exposed wound on the trunk or branches due to cutting or breaking of a side branch. *Polypores* usually attain the highest form among fungi regarding size, solidarity, and rigidity; some of them attain huge dimensions, sometimes in the form of brackets and hoofs on trunks and branches of big trees (fig. 1), weighing about 30 to 40 pounds. A tree may be attacked by fungi in all stages of its life-history, but specially full grown adult trees show signs of damage due to the attack at their central wood or through their roots. The life-history of a *Polypore* in general corresponds to that of a flowering plant. Just as a seed develops into a seedling, so a minute microscopic cell, called spore, germinates into a tube which, by branching, forms a tangled mass of threads called the mycelium. The mycelium is the vegetative part corresponding to roots, stems, and leaves of a green plant. After a time when the mycelium is well established within tissues of the tree or timber and has gathered sufficient amount of food from them, the *Polypore* forms a fruit-body on the outside, which corresponds to the flower of the green plant. Just as a flower ultimately produces seeds,

Fig. 1

FLOOR IN A LUMBER SHED COMPLETELY DRY-ROTTED
Fig. 2

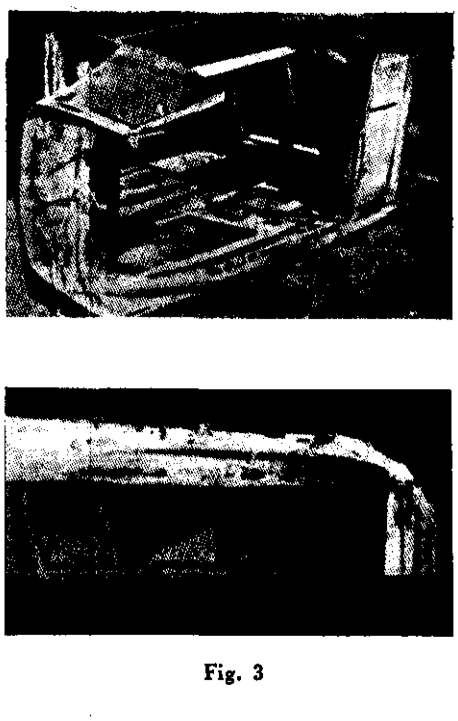


Fig. 3

POISONING THE PINHOLE BEETLE
Fig. 4

so a mature fruit-body ultimately liberates a number of spores. Besides this regular mode of reproduction by means of spores, in some cases secondary spores (vegetative spores) may be formed inside the host-tissues or on the outside, or a group of threads from the mycelium may be specialized for vegetative multiplication by breaking off and starting a new colony.

In studying diseases of the forest, fruit and timber-producing trees, the object is to learn how to fight and control them. For this we must know at least the general structure of the trees, the more common forms of their enemies, *i.e.*, knowledge of the fungi causing the decay, how they act on living trees, which organs they attack, and what the consequences are in the end. And finally we must study the remedial and preventive measures.

Trees grow in length by the apical parts of their twigs and root-ends, they grow in thickness by the so-called cambium, a very thin layer of actively dividing cells, between the bark and the wood of trunks, branches, and roots. The twig-ends and root-tips also consist of continually dividing active young cells. The growth in thickness (diameter) by the cambium produces in cross-section a number of annual rings in the wood, corresponding to so many years' growth in diameter. After a number of years the cells of the oldest annual ring of wood become dead and discoloured (coloured black); this is called the heartwood (the central wood lying in the core of the tree). The living wood outside the heartwood is called the sap-wood.

Polypores usually gain entrance into trees either by their roots or through a wound in the trunk, often through a dead branch stub. In *Indian Forest Utilisation* (1907) R. S. Troup has reported that among root-parasites, that is, fungi which enter the stem through the roots, the most destructive, hitherto detected, in India, is *Fomes annosus* which kills young *deodar* trees in the Himalayas and affects the wood of the lower part of the stem. Among those which attack the stem may be mentioned *Trametes pini* which causes red-rot in *Pinus excelsa*, *Polystictus egregius* which attacks *Dalbergia sissoo*,

Fomes fomentarius found on *Quercus incana* and *Betula alnoides*, and *Fomes fulvus* and *Fomes pappianus* which do much damage to *Xylia dolabriformis* and *Acacia arabica* respectively. In extreme cases of attack the tree becomes converted into a hollow cylinder due to the entire destruction of the central core or heartwood. Many of the heart-rotting *Polypores* on living trees rarely continue their activity after the tree has been felled and converted into timber. But sapwood is usually more easily decayed than heartwood, probably because the cells of the sapwood contain food materials that encourage the growth of *Polypores*, and also because the heartwood contains toxic materials for the growth of wood-destroying *Polypores*.

According to gross characters of the rot, the decays are usually divided into *white rots* and *brown rots*, depending on the colour of the decay; in the former case the wood becomes lighter in colour and in the latter, dark or reddish-brown in colour. The white rots usually show white patches or pockets, or the wood becomes generally lighter in colour throughout. The fungi causing white rot usually attack and remove only the lignin while those causing brown rots confine their attention mainly to the cellulose, producing a number of brown cubicle- or pocket-rots or general type of decay characterised by longitudinal splits. *Polystictus versicolor*, quite common in the tropics, causes an active white rot.

Fruiting of *Polypores* does not take place as a rule until the decay is well advanced, *i.e.*, until the fungi have spread throughout the wood of the tree, and it also depends on the access of light. The general method of attack is that when fresh spores settle on moist wood they germinate in presence of air just as do seeds in warm moist soil, and produce a mat of threads—the hyphae. The hyphae branch, creep over the wood, and take in food substances first from the cell-contents and then they exude a number of enzymes principally from their growing tips, by means of which they dissolve the cell-walls of the wood and ultimately feed on them. Thus, they advance by boring directly through the cell-wall or passing through the natural pits or openings on the wall.

The loss due to decay in buildings and storage-timbers, known as dry rot, is enormous. Houses built on damp soil not undergoing damp-proof courses as well as old houses built before the age of introduction of damp-proof courses, factories and business-premises requiring humid and warm conditions and cold stores fall an easy prey to dry rot. It is called dry rot, because the timber becomes ultimately dry and crumbling. All timber must be moist before it will decay and hence all dry rot-infections start where the timber has been subjected to considerable moisture. The most serious types of dry rot are caused by *Merulius lacrymans*, *Poria incrassata* and *Poria vaporaria*. According to K. St. G. Cartwright, 80 to 90 per cent. of the damage to house-timbers in England is caused by *Merulius lacrymans* which fortunately does not grow with us in the topics on account of the high temperature. Cartwright has recorded that *Merulius lacrymans* never occurs in nature, the fungus is always associated with man and his works, neither does it appear to be common in timber areas. The reason for this, according to him, is that in building sites conditions are extremely favourable to fungus-growth, often they are heavy clay-sites or low-lying ones where the water-table lies very near to the surface. In such locations dry rot (fig. 2) will almost certainly make its appearance in a short time unless due precautions are taken. Ventilation is of use in that it causes drying out of the wood work, but access of saturated air will be most harmful than beneficial. C. J. Humphrey, on the other hand, reported that in the United States *Poria incrassata* causes greater damage than any of the members of the *Merulius* group.

The decay due to *Poria incrassata* is quite similar to that produced by *Merulius lacrymans* and has probably been frequently confused with it, especially since the fungus is often found in a sterile condition (without formation of fruit-body). In common with *Merulius lacrymans* infections first start in moist and cool situations, preferably on timbers beneath floors which are either in contact with the ground or close to it. In the Albama Polytechnic Institute circular No. 78, of February, 1925, Dr. Humphrey has dealt exhaustively with the

distinguishing characters of *Poria incrassata*, illustrating his description with one beautifully coloured plate and several figures in black and white. The spores of *Poria incrassata* are dusky-olive, while those of *Merulius lacrymans* are rust-red; besides, there are important colour-differences in the mature fruit-bodies of the two, *viz.*, the mature fruit-body of *Poria incrassata* turns brown or brownish black while that of *Merulius lacrymans* shows tints of sulphur-yellow or lilac colour. *Poria vaporaria* similarly causes a rot practically indistinguishable from that of *Merulius*, but no sulphur-yellow or grey colour develops and the fruit-body is entirely different with spores not coloured. This fungus is of much rarer occurrence in England, but when present, is probably almost as destructive as *Merulius*.

Shallow damp mines are veritable fungus-breeding pits, owing to the equable temperature and humid conditions of the air. They serve as the most spectacular demonstration of the profuse growth of the wood-destroying fungi. When the growth of the fungus has not been disturbed, the fungal threads form thick curtains and all kinds of abnormal fungus growths appear owing to the absence of light. This is an example of purely vegetative growth in the dark at an amazingly rapid rate, and the damage to mine timber is very great. Albert Pilat has reported such profuse vegetative growth of a *Poria* (*Poria undata*) in Weinberger railway tunnel (1·14 kilometer long) in the dark in Prague, the infection spreading from the railway-sleepers and wooden structures. The fungus has spread over the whole tunnel alone and it has become a difficult problem how to eradicate it.

The various kinds of timber used in the manufacture of automobiles are not adapted to withstand the warm humid weather of the tropics; the woods selected are exclusively of the temperate-zone species as most of the cars used here are imported from Europe and America. The decay is caused by moisture. Free water gains access to the wood during the process of frequent washing or due to tropical rains beating around closed doors and windows. Under such conditions wood-destroying fungi (*Polypores*) get an easy footing (fig. 3), the infection thus occurring after the cars have reached the tropics.

once collected in September, 1932, a fruiting body of *Polystictus sanguineus* from the back corner of the inner seat of a closed-model car in Calcutta through the kindness of my friend mycologist Dr. H. P. Chaudhury. Dr. C. J. Humphrey reported from the Philippines in 1931 three species of *Polypores* fruiting on automobile-wood, *viz.*, *Lenzites striata*, *Polystictus sanguineus*, and *Trametes versatilis* ; they are all inhabitants of warm regions. He has suggested two alternatives for prevention of such damage ; either the manufacturer must select the heartwood of reputedly durable species of timber or else the non-durable woods must be treated with preservative by way of injection of creosote, zinc chloride or sodium fluoride solutions. In certain European made cars they are using nowadays durable tropical woods and these are giving very good service in the tropics.

Regarding control measures, prevention is the basis of the check of tree diseases. Very rarely it will be possible to save a tree or stand which has once been attacked by one of its dangerous enemies, we cannot save a tree infected by a heart-rot fungus, it is lost, even all of its timber cannot be saved, part being already destroyed. Surroundings of nurseries and plantations, therefore, should be kept in as healthy a condition as possible. Forests should be maintained in a better hygienic condition to keep off diseased stocks. In the case of timbers when the fungus has once gained entrance, the only feasible remedy is complete and thorough eradication of every trace of infection by cutting back at least two or three feet away from the visible source, and the sound portions should be at once treated with an antiseptic (creosote, zinc chloride, etc.) and dried. There is a popular article in *Pearson's Magazine*, No. 477 of September, 1933 (pp. 238-245), describing the work of the Forest Products Research Laboratory at Prince's Risborough, where the investigators are trying to control dry rot in the floors by artificially infecting them with *Merulius lacrymans* and then finding out a method of effectively sterilizing the infected timbers. They have erected an experimental dry-rot house in the Laboratory for this purpose. The difficulty is, as they remark, to reach the fungus inside the timber, as mere external treatment only kills superficial growth. The problem is not

yet solved but they have tackled it in right earnest. The Director, Mr. Pearson, appropriately remarks, " It is a long job. . . . We are steadily getting to know more about timber and to realize how much more there is to know." They are feeding living trees with arsenic (fig. 4) to kill the invading enemies.—(*Science and Culture,* May 1936.)

BAMBOO CULTIVATION IN THE U. S. S. R.

A peculiarity of bamboo is that it requires to be steamed before use. This leads to a reduction in its diameter whereby the wood becomes more compact through loss of moisture, and shrivelling and cracking is provided against. During steaming, bamboo oil comes to the surface from the lower layers and spreads itself evenly over the whole surface of the cane. The steaming of bamboos is carried out in special, hermetically sealed chambers where steam is passed over it at atmospheric or slightly increased pressure. On cooling, bamboo, which has been so treated, has a polished surface looking as though it were covered with a natural varnish which is highly resistant to atmospheric influences and injuries.

Unsteamed bamboo is distinctly inferior to steamed bamboo in strength and is bound to crack eventually though it may be only after a very considerable period of time.

The manufacture of the first group of articles has been mastered in Soviet factories and some of the processes have been mechanised (*e.g.*, at the Chakvin Sovsport bamboo factory).

Bamboo Cultivation in the U. S. S. R. (" ***Economic Survey Monthly Bulletin,***" Vol. IX, No. 1, January 1937, issued by the U. S. S. R. Chamber of Commerce.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for June, 1937:

IMPORTS

ARTICLES	MONTH OF JUNE					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	70	..	..	9,996	..
French Indo-China ..	..	76	92	..	8,902	10,333
Burma ..	..	..	15,143	..	..	18,65,282
Other countries ..	..	..	85	..	..	7,292
Total ..	..	146	15,320	..	18,898	18,82,907
Other than Teak—						
Softwoods ..	1,256	815	1,969	79,598	45,524	1,48,580
Matchwoods ..	..	813	1,380	..	40,243	82,810
Unspecified (value) ..	..	..	..	1,67,716	24,007	2,04,894
Firewood ..	4	20	36	60	316	540
Sandalwood ..	12	23	10	6,421	8,054	5,283
Total value of Wood and Timber ..	..	..	..	2,53.795	1,18,144	4,42,107
Manufactures of Wood and Timber—						
Furniture and cabinet-ware ..		No data			No data	
Plywood ..	..	284	502	..	62,037	1,11,525
Other manufactures of wood (value) ..	..	..	..	2,02,250	1,29,510	1,47,976
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,02,250	1,91,547	2,59,501
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	44,538	26,821	23,756	2,92,111	1,65,276	1,94,917

EXPORTS

ARTICLES	MONTH OF JUNE					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	4,727	2,515	2	9,24,253	5,12,620	520
,, Germany ..	922	401	..	2,12,881	99,678	..
,, Iraq ..	100	51	7	16,416	6,350	1,422
,, Ceylon ..	28	..	..	3,080	..	..
,, Union of South Africa ..	297	826	..	47,216	1,75,293	..
,, Portuguese East Africa ..	128	167	..	23,666	28,422	..
,, United States of America ..	86	23	..	21,552	5,556	..
,, Other countries ..	422	1,421	72	87,474	3 03,145	19,540
Total ..	6,710	5,404	81	13,36,538	11,31,064	21,482
Teak keys (tons) ..	707	383	..	1,02,725	57,525	..
Hardwoods other than teak ..	76	130	..	7,580	15 011	..
Unspecified (value) ..	..	..	..	33,406	20,628	1,03,893
Firewood (tons) ..	..	..	..	..	..	..
Total ..	..	..	..	1,43,711	93,164	1,03,893
Sandalwood—						
To United Kingdom ..	..	..	..	..	..	..
,, Japan ..	13	5	..	13,413	6,000	..
,, United States of America ..	..	52	107	..	51,600	1,08,000
,, Other countries ..	11	6	35	12,392	8,202	35,919
Total ..	24	63	142	25,805	65,802	1,43,919
Total value of Wood and Timber ..	..	..	..	15,06,054	12,90,030	2,69,294
Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	14,840	6,320	22,957
Other Products of Wood and Timber ..	No data			No data		

INDIAN FORESTER

OCTOBER, 1937.

SINGLE-TREE SILVICULTURE IN INDIAN CONIFERS

BY R. MACLAGAN GORRIE, D. Sc.

Summary.—A suggestion is put forward that the final crop in conifers should be selected at a very early age and the *élite* trees, chosen for their excellence and at a spacing suitable for the final crop, should be distinctively marked and favoured by heavy crown thinning.

Discussion in European silviculture has recently centred round an intensified application of the Selection System known in German as Einzelstammwirtschaft, which literally means "the management of the individual stem." The success of the many European variations in intensive selection management is readily understood when it is realised that the crops dealt with, namely spruce and fir, are shade-bearers which flourish under a certain amount of suppression from older trees above them and which are therefore naturally adapted to unevenness in age. The arguments in favour of such systems cannot be applied to our Himalayan conifers (*Cedrus deodara*, deodar, *Pinus excelsa*, kail, and *Pinus longifolia*, chir) because these are all light demanders which occur naturally in even-aged groups, and which if once suppressed even slightly, seem incapable of recovering the full vigour associated with their uninterrupted development. The very fact that suppression or severe competition does damage a tree's prospects points on the other hand to the need for studying the requirements of the individual tree rather than of the crop as a whole, because it is only by judicious encouragement of *élite* stems from early youth upwards and right through to the final crop that well sustained and regular increment can be ensured.

In the management of the Himalayan conifers there are two outstanding problems connected with the rate of growth: (*i*) one is the frequency and cost of thinnings which can be justified in the

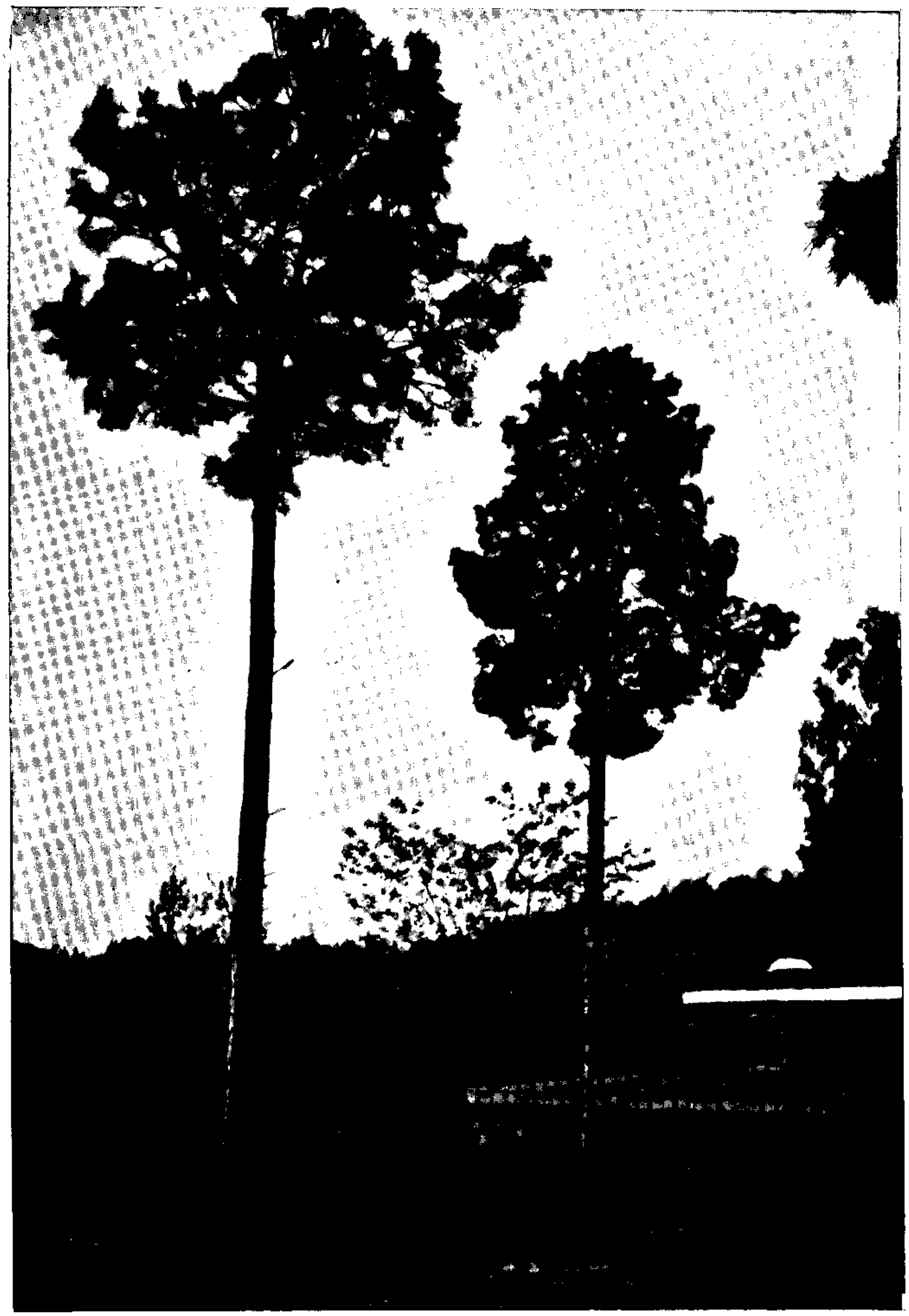
sapling and small pole stages when thinnings are unsaleable, (*ii*) the other is the difficulty of getting dense crops to grow at the rate visualised by the rotation age as fixed by the Working Plan. Some discussion of each of these problems may help to justify the suggestion put forward in the latter half of this paper.

The cost of thinning unmarketable pole crops has always been a limiting factor, because most of our coniferous crops are far from any market and the smallest saleable size is usually that which will produce (*a*) a single sawn scantling from the basal log, *i.e.*, a tree of D.B.H. 16", or (*b*) on axe squared *karri* with 6" sides—*i.e.*, a tree of D.B.H. 12". The market for the latter is somewhat limited, and the percentage of breakage in river transport of the clumsy *karri* poles is heavy. The local market for *karries* is often fairly good as they are much used in the half-timbered houses of the hill folk, but most of their requirements are met as free grants under which it is often very difficult to get thinnings efficiently carried out except in the immediate neighbourhood of the right-holding villages.

The net result has been that either (*a*) regular thinnings on a 10- or 15-year thinning cycle are carried out at considerable cost in crops of 20 to 60 years of age or (*b*) owing to expense thinnings have been left undone until the crop reaches an exploitable size ; this size may not be reached until about the 80th year owing to the cumulative effects of competition in dense stands, while the temptation to remove the best stems merely because they are exploitable has always to be guarded against among poorly paid and ill-educated subordinates.

Some of our chir forests in populous foothill tracts around Rawalpindi and the larger Kangra townships can be thinned at almost any age with the comforting knowledge that every stick can be sold, but this alters rapidly as one gets into less populous parts. What is needed is a regime of early thinnings which can be carried out in all cases, whether commercially profitable or not, at the minimum of expense.

To turn now to the rotation age, this is fixed under most Working Plans at about 120 years for a 6-foot girth chir pine and 150 years



EXAMPLES OF GOOD CHIR PINE CROWNS WHOSE DIMENSIONS ARE QUOTED IN THE ACCOMPANYING ARTICLE. SUCH CROWNS ARE NOT BEING PRODUCED BY OUR PRESENT THINNING PRACTICE, BUT ARE NECESSARY IF SATISFACTORY INCREMENT IS TO BE OBTAINED

for a $7\frac{1}{2}$-foot girth deodar, the larger size for the deodar being necessitated by the principal deodar market size, namely railway sleepers, and by the fact that most deodar forests are less accessible than our chir ones, so that small dimension stock simply does not pay its way.

In both cases the rotation age visualises a steady diameter increment of 5 rings per 1″ diameter, and it was hoped that regular thinnings would produce this in the majority of crops. From recent remeasurements of sample plots for a great variety of site qualities of both deodar and chir it can safely be said that the average increment in crops regularly thinned to about C grade is definitely below this rate of growth. It is true of course that a number of individual stems in each acre are well above this figure, but their occurrence seems to be more or less fortuitous and is not the intentional result of the thinnings so far made. Steady and satisfactory increment is inevitably associated with a crown shape and size which could not possibly be produced by starting C grade thinnings half way through the life of the crop. These full-crowned trees have started life with some initial advantage, such as escape from early fires, or a slight advantage in age or opportunity, and have continued to hold this lead throughout their life. Some foresters might even classify them as wolf trees and remove them in thinnings, but the fact remains that such trees are the only ones which are going to fulfil the growth requirements of the modern Working Plan. Unfortunately, being fortuitous, there are seldom enough of such trees in any given acre to constitute a complete final crop after the poor performers have been removed.

The type of crown which might be taken as ideal is shown in Plate 41 which illustrates two chir at Panjar, Rawalpindi East, of girth just over 6 feet, total height 91 and 94 feet, width of crown 21 to 24 feet radius, and depth of crown 1/3 and 3/7 of the total height. Such crowns are not being produced except by accident in our even-aged and lightly-thinned crops, but seem to be the result of nature's own single tree selection in light demanding species which occur naturally in more or less even-aged groups. What is required

is some system of thinnings which will ensure a full stocking of such full-crowned vigorous trees, by copying nature's methods more accurately than has been attempted under C grade thinnings.

The next question is : What constitutes a fully stocked mature conifer stand ? A reference to the various Yield Tables will show that for quality II crops at 120 years, the figures of trees per acre are : deodar 209, kail 132 and chir 47. At 140 years the figures are deodar 180, chir 44. In actual practice there is not such a large discrepancy between the species as these figures indicate. The figures for deodar and kail are too high while that for chir is too low, and the finally thinned crop at the stage just before preparatory or seeding fellings are introduced could safely be taken for all three species as 70 trees per acre. This at least is a reasonable figure to aim at, though doubtless individual acres of particularly well stocked mature deodar and kail crops can be found to exceed it, and have been measured in order to draw up the Yield Tables in question.

My proposal is by no means original as the marking of single selected trees in young crops has proved practical in New Zealand and U.S.A. It is that a wider use be made of the single tree method in the early stages of the crops and followed through to its logical conclusion. If we follow nature's method in spirit rather than in the letter we will *select the trees that are to be kept, not those that are to be removed* in thinnings.

Where masses of natural seedlings have come up, clean them in the ordinary way to a 6-foot spacing, then when they are about 20 feet high and the naturally vigorous plants have had time to assert themselves, mark your 70 trees per acre with a good creamy ring of white paint which cannot be overlooked or lost sight of. The average spacing (triangular, not square) is 27 feet apart, but a good deal of latitude can obviously be allowed in order to ensure the selection of the best individuals as the *élite*. The total number of *élite* marked can be checked over any known area such as a marking section or sub-compartment, in order to ensure that approximately the correct number has been selected.

The next step is to mark for thinning, removing only such crowns as are interfering, or are likely to interfere, with any of the *élite*. The rest of the crop in the intervening spaces can be left to struggle along and can be harvested as and when individual stems reach merchantable size, which will probably be not very different in point of time or class of output from the present yield of C grade thinnings. Sufficient of these "also rans" should, however, be retained through the early pole stages to cover the ground and to provide a reserve against calamities such as wind-break or fire. Recurring thinnings at 5- or 10-year intervals should, however, be concentrated upon keeping the crowns of the *élite* free.

One weakness of this proposal may lie in the danger of fire in the early pole stages; particularly in chir any serious fire would tend to seize upon the backward groups of "also rans" and from them climb into the crowns of the *élite*. If this danger is likely to be a serious one, the cure is to give more elbow-room to the *élite* trees so that their crowns are more completely isolated from the rest of the crop in the earliest thinning operations. Apart from this consideration it is on the whole advisable to keep the *élite* trees reasonably closely confined by their "also ran" neighbours because if they are deprived of all competition they would tend to turn into real wolf trees.

Many foresters will consider that such an early introduction of the crown thinning principle will produce knotty and branchy coarse-grown timber. Recent observations in sample plots tend to show, however, that the persistence of branches down to near ground level is quite as commoner amongst partially suppressed and poorly developed crowns than amongst full crowns. A healthy tree is so fully occupied in developing its upper crown that the shade of its own canopy and of the side shade of its not-too-close neighbours should be sufficient to check the development of its lower branches.

Sample plots are being laid out now in all three species to test the accuracy of this proposal and to provide figures which will show the relative efficiency in increment, crown production and natural cleaning of branches as between early crown and ordinary thinnings.

SOME NOTES ON THE KAMRUP METHOD OF SAL REGENERATION

By H. G. CHAMPION, I.F.S.

Many foresters concerned with the regeneration and management of sal will have read Mr. MacAlpine's paper contributed to the last Bengal Forest Conference (*Ind. For.*, 1937, pp. 476-487) with the greatest interest. The publication of the results of further experience of the practical application of Milroy's views on the natural regeneration of sal in Kamrup which have been obtained since the " Sal Committee " visited the area in February 1933, has been awaited almost with impatience by some of us. It is evident that Mr. MacAlpine had not seen the Inspector-General's note on his tour of Assam in January 1936, and had probably written his paper before it was published, but in considering developments the two should be read together. The " Sal Committee " (not only the Central Silviculturist !), after carefully considering all the evidence before it in the records, the experimental plots, and the regeneration areas, and the Inspector-General's report (then Mr. Blascheck) on his visit the previous season, came to conclusions that " *whilst the method of regeneration may still prove possible, it would appear to be far **slower than** was anticipated* " and that " *further fellings have become silviculturally impossible.*" It recommended *inter alia* further *investigation of the potentialities of rains weeding*, continuing the burning regime much as prescribed in the working plan. From both the recent publications referred to, it appears that four years' experience since February 1933 has amply justified the advice of the Inspector-General and the " Sal Committee " (referred to as resulting in " pessimistic prognostications ") which could be summed up briefly as " Your rate of regeneration is too slow for your felling prescriptions. Go slow with fellings till you have found practical means of speeding up the rate of development of your unestablished regeneration."

It is stated that in 1933, Milroy, after further inspections decided to carry on Bor's plan in its entirety, but the essential point was

conceded, *i.e.*, fellings were considerably reduced if not entirely abandoned in P.B.I. Full particulars are not available to the writer, but it is mentioned by the Inspector-General of Forests that the yield is still advisedly curtailed and it is abundantly apparent that the *striking improvement reported in the rate of development* of the regeneration is due to the improvements in technique, above all by rains weeding. This was not included by Milroy as part of his method nor was it in Bor's plan, and it still appears to be the turning point, the chief factor in rendering it possible for the Inspector-General to write now that he is " convinced from what I have seen that the present work has every promise of success." That in a sal forest with evergreen undergrowth in which regeneration is impossible, a proper regime of cutting back the evergreen undergrowth and burning will alter conditions back to a sub-climax with grass in which sal can regenerate and gradually establish itself, was Milroy's great contribution to this long standing problem, and was the essential point of Bor's plan for the Kamrup forests. It is, I assert, still correct to say that at that time the available information as to the rate of development of seedlings from the stage when the grass had just displaced the evergreen, was insufficient to justify the rate of felling prescribed. An experiment was being made on a working plan scale before it had been tried out on a small scale ; the basis was direct observation accurate in every respect except that the time factors which ultimately regulate the regeneration period and the yield, could only be guessed (*cf.* p. 480, line 10). It thus appears that Mr. Simmons' assertion that the fellings must be slowed down *till regeneration could be persuaded to catch up and keep up* with them, and his demonstration of the potentialities of rains weeding, both matters in which the Inspector-General of Forests and the " Sal Committee " supported him, have been justified by the passage of time. That success is now believed to be in sight is obviously due to the excellent way in which Mr. Jacob has improved the burning technique to the standard anticipated by Messrs. Milroy and Bor (*I fancy with vastly more labour than they originally had in mind*), and to that weeding technique which is now in several

provinces realised to be the real key to ensuring establishment of sal regeneration within a reasonable period of time. While considerable success has been obtained in Kamrup due almost entirely to the personal zeal of the Divisional Forest Officer, no progress has as yet been made in Goalpara which has a similar plan prepared in 1929-30. The position remains the same as at Mr. Blascheck's visit in 1932, the *sau* grass is as vigorous as ever and no regeneration has come up. Sir Gerald Trevor in his inspection note deals with this very serious state of affairs. He mentions that while some of Mr. De's experimental areas give promise of success, the fact remains that in this division no regeneration has been obtained under the working plan. It is still correct to say that further fellings in P.B.I. have become impossible.

There are a few other points on which comment may be made. Are the areas mentioned (p. 480) as now completely regenerated and transferred to P. B. V. (note that there is no mention of a *revision of the plan!), areas which have been regenerated from closed* high forest under the "Kamrup method"? If so, development must have been phenomenal in the last four years. Or are they areas where Boko conditions prevailed? in which case there is nothing surprising. One would also like to know what exactly is the share of the work done by the forest guards (p. 479, line 28), or what area under regeneration one guard can deal with unaided.

The two forms of *Imperata* appear to be recognisable in most localities, usually with different vernacular names. The small one would appear to be depauperated by any unfavourable conditions such as repeated burning (fire lines), overgrazing, or even poor soil.

In discussing the application of the "Kamrup method" (albeit with the inclusion of rains weeding) to Bengal forests, Mr. MacAlpine appears rather scared at the contemplation of probable costs, and makes us wish he had been more informative concerning this aspect of the subject in his account of the work in Assam, debiting in full the value of the labour obtained free or cheap. I agree with him that the results of past experiments in Bengal are disappointing but not conclusive, and would invite his attention to the lack of quantitative

data: it is not enough to get an occasional seedling to develop, he has to get in and get up a *crop* of seedlings. In his experiments, he must record just what regeneration he starts with and what he has obtained *as a result of the treatment* applied, and he must record it in such a way that others later on can make no mistake about it, failure to do this being in great part the explanation of the different deductions drawn as to what must have happened in the plots in the Kamrup foci.

The developments in Assam parallel those of the last few years in the United Provinces, in indicating that at last we can feel, and can produce evidence to show, that we are near the solution of the sal natural regeneration problem in our important forests. We can even anticipate that when the Empire Forest Conference visits India in 1940 we shall find it difficult in some regeneration areas to convince them there ever was a time when we had to admit complete failure.

NOTE ON CASUARINA EQUISETIFOLIA PLANTATION IN KARWAR

By D. S. Kaikini, Range Forest Officer, Karwar

Summary.—The casuarinas first introduced in Karwar in 1868-69 on a small scale now cover 431 acres of narrow sand belts along the coast.

The supply of fuel, protection from high winds and storms and aesthetics are among the objects for the plantations.

Clear-felling by 15 years' rotation and artificial planting are adopted with two thinnings in fifth and tenth years.

Karwar is a port on the west coast 270 miles south of Bombay. The town is described to be one of the most beautiful in the world by eminent men and various Governors who have visited Karwar. The town is beautiful owing to the natural scenery of the hills, the vast sea and a lovely beach, and the artificially made plantations of casuarina along the sea shore lend colour to enhance its beauty.

No better description than that by poet Tagore can be aptly given and it is reproduced below :—

> " . . . Its crescent shaped beach throws out its arms to the shoreless open sea like the very image of an eager striving to embrace the infinite. *The edge of the broad sandy beach is* fringed with a forest of casuarinas broken at one end by the Kalinadi river, which here flows into the sea after passing through a gorge flanked by rows of hills on either side."

It is, therefore, intended to give a short note on casuarina plantations.

The casuarina is an exotic and was introduced in India from Australia. It was first introduced in Karwar in 1868-69 and 10 acres on the sea beach were planted as well as avenue of trees along the main road, under orders of the Collector. Thereafter regular planting was continued.

For the first time in 1878 His Excellency the Governor paid a visit to the plantation and expressed great pleasure at the results.

The plantations in the Karwar Range cover an area of **431** acres in four separate bits along the sea coast of an approximate length of six miles from end to end but broken at one end by the Kalinadi and by promontories of hills. The area comprises (1) Chitakula 199 acres, (2) Kodibag 48·4 acres, (3) Binge 39·6 acres, and (4) Arge 144 acres.

The casuarina plantations are situated on tracts of pure deep sand thrown up by the sea, and form narrow belts fringing the coast.

The average rainfall for 10 years from 1924—1933 has been 128·1".

Up to the year 1903, no regular fellings or thinnings were undertaken ; only fallen and dead trees were extracted. Fellings over 6 acres each year were commenced in Kodibag from 1907-08 and the clear-felled areas were planted up. Since 1909-10 fellings have been regulated according to the prescriptions of a working plan. The system employed was clear-felling and planting in the following year. A rotation of 30 years was adopted.

The objects in raising the plantations are—

(1) supply of fuel to the Bombay markets and to obtain the maximum financial return ;

(2) to protect the sea coast from erosion and afford shelter from high winds and storm ;

(3) to arrest the sand from being blown inland into cultivation ; and last, but not the least,

(4) to add beauty to the sea-shore.

The system employed is clear-felling and artificial planting as it is the only suitable one for this species on account of its strong light-demanding qualities and its fast-growing capacity.

The rotation fixed now is 15 years and two thinnings, one at the age of 5 and the other at 10, are prescribed.

The working plan has been revised recently by Mr. E. T. C. Vas, Divisional Forest Officer, W. D. Kanara, and the description of working given in this note is drawn from this working plan.

The average area of each coupe is 28·7 acres and there are 15 coupes. Each coupe is sold standing in April or May and is felled in the rains and work completed by end of April next and the area is artificially regenerated in the following rains.

Nurseries are prepared in November close to the area to be clear-felled. Natural seedlings are available in large numbers along the sea-shore, under large parent trees. These seedlings are pricked in nursery beds at 4″ × 4,″ when they are about 3″ to 6″.

The seedlings look like blades of grass and only a trained eye can identify them. The seedlings in the nursery are watered daily till the end of May, by which time they grow into plants 4′ to 6′ high and are ready for transplanting in June. It is my experience that plants of 4′ to 4½′ height are the best for transplanting as they strike well and easily and are not subject to the attack of crickets (*Brachytrypes achatinus*). These crickets are very active during September and clip off the leading shoot at a height of about 2′ from the ground and kill the plants outright. They live in small holes in the ground under the plant and come out at night and jump to a maximum height of 2′ and are active only after nightfall. In the

day time they live in the holes and feed on the needles collected in the holes. It is therefore found by experience that a plant of 4′ to 4½′ high can easily withstand the attack.

Before transplanting is commenced in mid-June and July, the area to be planted is lined out and points marked on the ground 12′ × 12′ square. The plants from the nurseries are removed and transplanted in the plantation in June or July while it is raining. A hole about 12″ to 15″ deep is dug in the sand with a *powrah* at the points previously marked and each plant planted in it and about a "*ghada*" of water (2 gallons) is poured in each hole and the earth trampled so that the plant is fixed firmly. Though there may have been fairly good rain prior to planting a layer of sand below 4″ from the surface is found dry. Watering helps to keep it wet. Stakes are fixed and the plants tied to each lest the strong south-western wind should make the plant swing or should make it bend down and so injure the leading shoot. In a week's time the transplants strike and are established. Up to October the plantations receive rain from the south-west monsoon and also from the thunderstorms of the south-east monsoon.

The plants are watered from November to May, ponds are dug for the supply of water. The water table is high varying from 5′ in the best areas to 10′ in the worst. Watering is done by women on daily wages. The area is divided into one acre plots, each woman being in charge of three plots one of which she waters every day. She can manage about 300 plants a day, *i.e.*, about one acre. The same part receives water on the fourth day again. Plants thus receive water twice every week. Each watering consists of about two gallons of water per plant. A basin around each plant is prepared for receiving the water and dry grass is spread under the plants to retain moisture and to prevent depressions forming under the plants by the force of the water when poured from a height of 3′ or so. Watering is done in the first year of the plantation and thereafter discontinued.

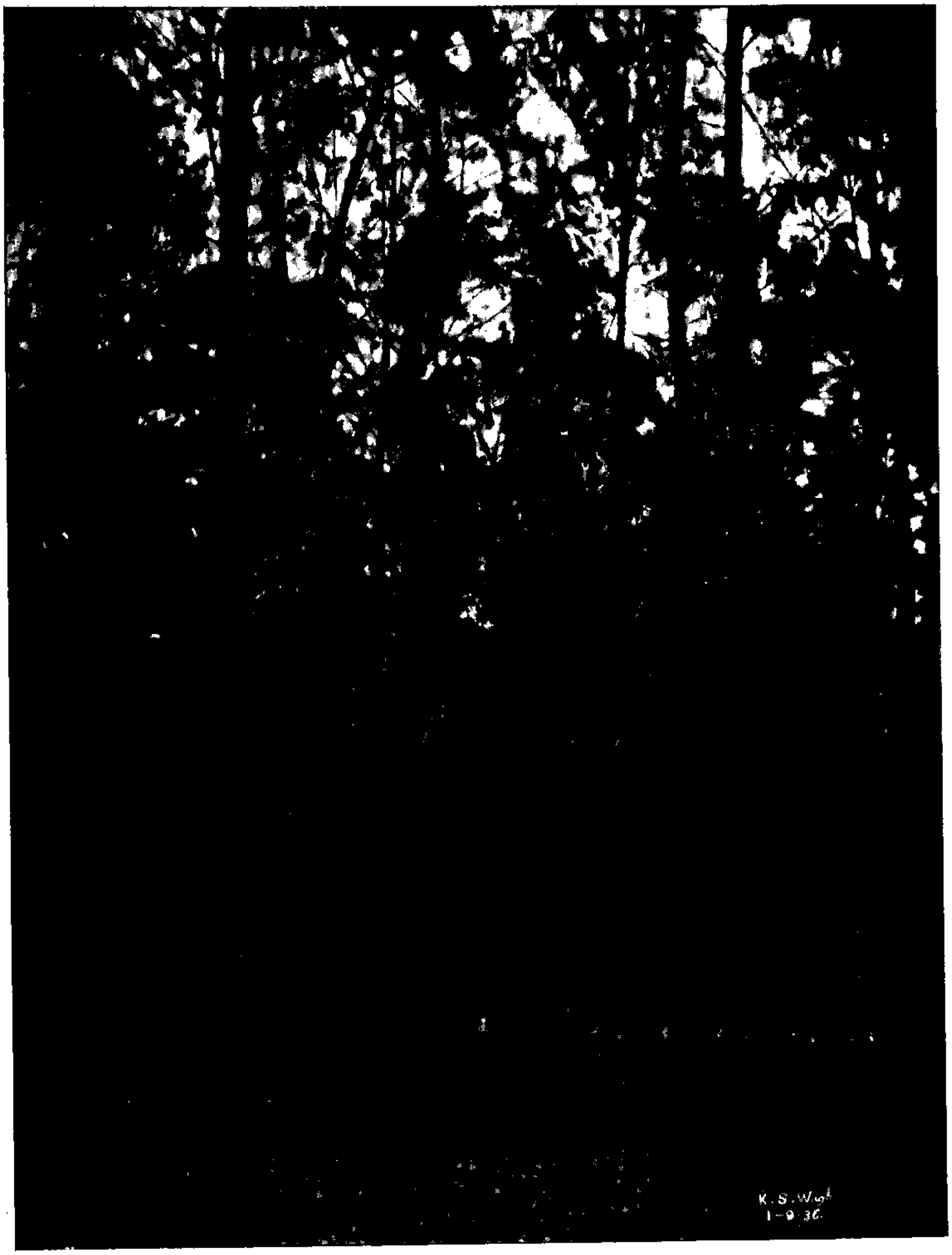
A fairly strong fence is necessary to prevent damage by cattle. Before the revision of the plan the fencing was erected at some cost

CLEARFELLED AT THE AGE OF 15 YEARS. IN THE FOREGROUND IS SEEN THE CONTRACTOR, MR. HALDIPUR, WHOSE FAMILY HAVE BEEN WORKING THE CASUARINA PLANTATIONS FOR OVER HALF A CENTURY.

PLANTED IN JUNE-JULY 1936. TRANSPLANTS WERE 7 MONTHS OLD IN THE NURSERY. THE WHITE SAND IN THE BACK INDICATES THE WATER POND.

PLANTATION RAISED IN 1934 AND NOW IN ITS THIRD YEAR.

Photos: K. S. Wagh.



THINNED IN 1934. 78 TREES PER ACRE REMOVED. SO FAST IS THE RATE OF GROWTH THAT THE CANOPY HAS BEEN ALREADY CLOSED UP. THE PRESENT AGE IS 7 YEARS

PHOTO NO. 7 *Photo: K. S. Wagh.*

to Government. The costs on creation of a plantation were found to be high on account of the fencing. In the revised plan it is proposed that the fencing should be erected by the contractor who purchases the coupe, at his cost, from the lop and top below 9″ in girth after the trees in the area are felled. It was feared that this condition would tend to considerably diminish the prices of the coupes but in actual practice there is no need to apprehend such fears, for, in the last 2 years this has not affected the prices of the coupes to any large extent.

The casuarina grows very fast. The average height growth per annum is 6′ and the diameter growth is 1·11″. Plate 42 shows a plantation raised in the rains of 1934 and the reader will certainly be astonished to find the trees grown so high by the middle of October. The stakes of the barbed wire fencing in the foreground are $4\frac{1}{2}'$ high.

The marking for thinning is mechanical and therefore simple. The working plan prescribes that each alternate line of trees is to be marked for removal. This arrangement leaves the trees at 12′×24′ after the first thinning. At the second thinning the alternate trees in the previously unthinned lines are to be removed leaving the spacing at 24′×24′. Though this is so on paper, actually, however, certain good trees in the lines to be removed are left standing if those on either or one side of these trees have been damaged by wind, suppression or other causes in which case the latter are removed.

The final felling is done in the fifteenth year. All trees suitable for poles are converted into poles of suitable lengths. Other trees are felled and immediately turned into billets of 3′ lengths which are arranged in neat stacks of 10′ to 50′ lengths. The brushwood is collected in heaps and left until April for erecting a fence round the area to be planted in the following rains.

The fuel stacks after measurement by the Range Officer are dismantled and the billets carried as head loads to the sea-shore for loading into small boats and thence into country craft locally known as *machwa* for shipment. The fuel is mostly shipped to Bombay where it is bought up for domestic use. Years ago this fuel was used

in Bombay by factories and all classes of people for cooking. But with the introduction of coal in factories and other up-to-date methods of cooking the sale of fuel has diminished. Poles and rafters find a ready market in Cutch-Mandvi in Kathiawar, where the story goes, that when one *machwa* was being unloaded there were some Japanese steamers in the port and people named the casuarina poles "Japanese teak"—an original idea but a travesty of names. The poles and rafters are used in Cutch-Mandvi for temporary houses of the poorer classes of people. They are also exported to Bombay and are used for scaffolding. It is also likely that there will be a market for poles for electric transmission lines and telephone lines, as treated with Ascu they are said to last a long time.

The average prices per acre of the casuarina plantations realised during the ten years from 1924-25 to 1933-34 in the Karwar Range are Rs. 192 (this was when the fences were erected departmentally). The average price realised during the two years 1935 and 1936 per acre is Rs. 146·42 and this includes the work of erecting a fence by the contractor. The high average prices per acre were obtained at a time when there was ready market for fuel and good sale in Bombay. The prices realised in 1924-25 were as high as Rs. 379·7 per acre.

The cost per acre for creation of a plantation is given below:

		Rs.
(1) Nurseries	..	3
(2) Fencing	..	8
(3) Water ponds	..	4
(4) Planting	..	2
(5) Props	..	2
(6) Watering	..	18
(7) Supervision	..	1
		38

Though fencing is to be erected by the contractors the cost on it is included for purposes of calculations. It may be that at a later date fencing may have to be done by the department again.

The average revenue per acre obtained from the plantations is as follows :

			Rs.
I thinning, 5th year of creation		..	7
II do. 10th	do. ..	..	15
Final felling, 15th	do. ..	..	125

(*Note*.—It is estimated that Rs. **125** per acre would be a fair amount to be expected in future from the final fellings.)

It is expected that the annual net revenue in future would be Rs. 86-9-0 per acre from the plantations of this Range, after calculating interest at 2 per cent. only.

The outturn of fuel per acre from these plantations is 2·1 tons from first thinning ; 3·6 tons from second thinning ; and 22·8 tons from final fellings.

(*Note*.—1 ton = 1 stack of $9' \times 4\frac{1}{2}' \times 3'$ considered equivalent to 100 c.ft. of stack measurement.)

The casuarina plantations are of special interest to Karwar. Apart from the Government plantations, many people have recently started to raise plantations on their private lands which are of no use for rice cultivation. The private individuals are also managing their plantations more or less on the same lines as the Forest Department. They find it more profitable to grow casuarina and sell it to local contractors.

Some poorer classes of people are content with raising plants on a modest scale on mounds of sand in the midst of their fields to protect the sand-hill from being blown into their fields. The trees yield them small-sized fuel for their own use and poles and firewood in about 8 to 10 years.

The Municipality is raising casuarina for avenue trees and sells a large number of the older trees and makes a fair amount of revenue. In the years 1934 to 1936 the Municipality sold 104 trees for Rs. 520, the average price realised per tree being Rs. 5, the biggest trees sometimes fetching as much as Rs. 15 each in open auction sales.

In short, while the department has been successful in reclaiming sandy areas and sea beaches by planting casuarina and adding greatly to the æsthetic side of the town and preventing sand from the sea-shore being blown into the cultivations inland and also in providing fuel and poles for the market, the people have also been greatly benefited by the cultivation of the species, a feature most encouraging to themselves and the department, and nobody will be better pleased than the department itself if plantations were further extended and economically used by individual efforts.

SANDAL IN GUJARAT

By Maganlal Desai, Forest Officer, Palanpur

Summary.—The note describes how the author has raised sandal trees in Balrampur forest, Gujarat.

Twenty-two years ago, while working as Superintendent of the Baroda Model Farm, I first came to know about *Santalum album* through a question asked by His Highness the Yuvraj of Mysore, who paid a special visit to the farm to see personally the working of the Borstal system. I happened to stand near two sandal trees and was asked whether we had sandal growing in abundance in this part of the country. I was told that the species growing at the farm was a good one and having regard to the appearance of the trees it was suggested to me that sandal stood a very good chance of growing well in this part of Gujarat. Since then I was always on the lookout to collect further information and whenever I got a chance of seeing this tree, I used to make inquiries in the matter and take notes.

From inquiries made from time to time it was found that in Charotar (Central Gujarat) sandal grew in good number before the great famine of 1900 in many villages, but gradually began to disappear through years of scanty rainfall, helped by a bye-law of the Baroda Government, under which sandal trees are considered to be State property wherever they grow. In the year 1919, when in charge of Vadgam Tehsil (under Palanpur State), I again came across these trees in good numbers in Sendhni beat. The trees were mainly

growing on good loamy soil (*saran* land) which is low-lying and marshy. In this tract *kamod* (a very good variety of rice) and sugarcane (without irrigation) were standing and on the border the sandal grew in luxuriance in *cactus* (*Opuntia dillenii*) hedges. The trees were 10 to 15 years old and their number was more than 300 at one place. The supervision work was done by the Forest Department. Sandal seeds were collected and were sown in suitable land with every care for three successive years. The efforts in this direction were not successful owing to various causes.

In the year 1931, when the Forest Department (Palanpur State) was placed under my charge, I got the first and real opportunity of studying this tree. My predecessor, Mr. Gupchup, had made several attempts at growing sandal in the Balaram jungles and as a result of his efforts some 200 plants (one year old) were seen at various places. I examined each and every plant, their habits, mode of growth, and the various places where they were growing and directed my subordinates to change their methods regarding the wholesale scattering of seeds without rhyme or reason. It was found out that the most healthy plants were growing under *ardusi* (*Adhatoda vasica*), a small shrub which grows naturally in abundance in marshy and sheltered places. In the next monsoon the seeds were sown according to instructions and a splendid crop of about 1,000 young trees was counted next year. From this I was led to deduce that there must be some kind of relation between sandal and particular sets of trees. A deep and careful study of the literature on the subject, particularly " The host plants of the Sandal Trees," by Rama Rao, Conservator of Forests, Travancore, who has done special work in this line (Indian Forest Records, Vol. II, Part IV), revealed the truth that sandal grew as a parasite on various kinds of trees about 144 in number. Rama Rao's researches have been supported by Dr. Berber in his studies in root-parasitism, the haustorium of *Santalum album*, Vol. I, No. I (Memoirs of the Department of Agriculture in India). Helped by this information, a series of experiments were planned and carried out in the forest nursery at Palanpur dealing with all available trees growing in State jungles for three successive years and the result of

my observations and experiments is as follows :

(1) Sandal would not grow and survive as individual independent tree.

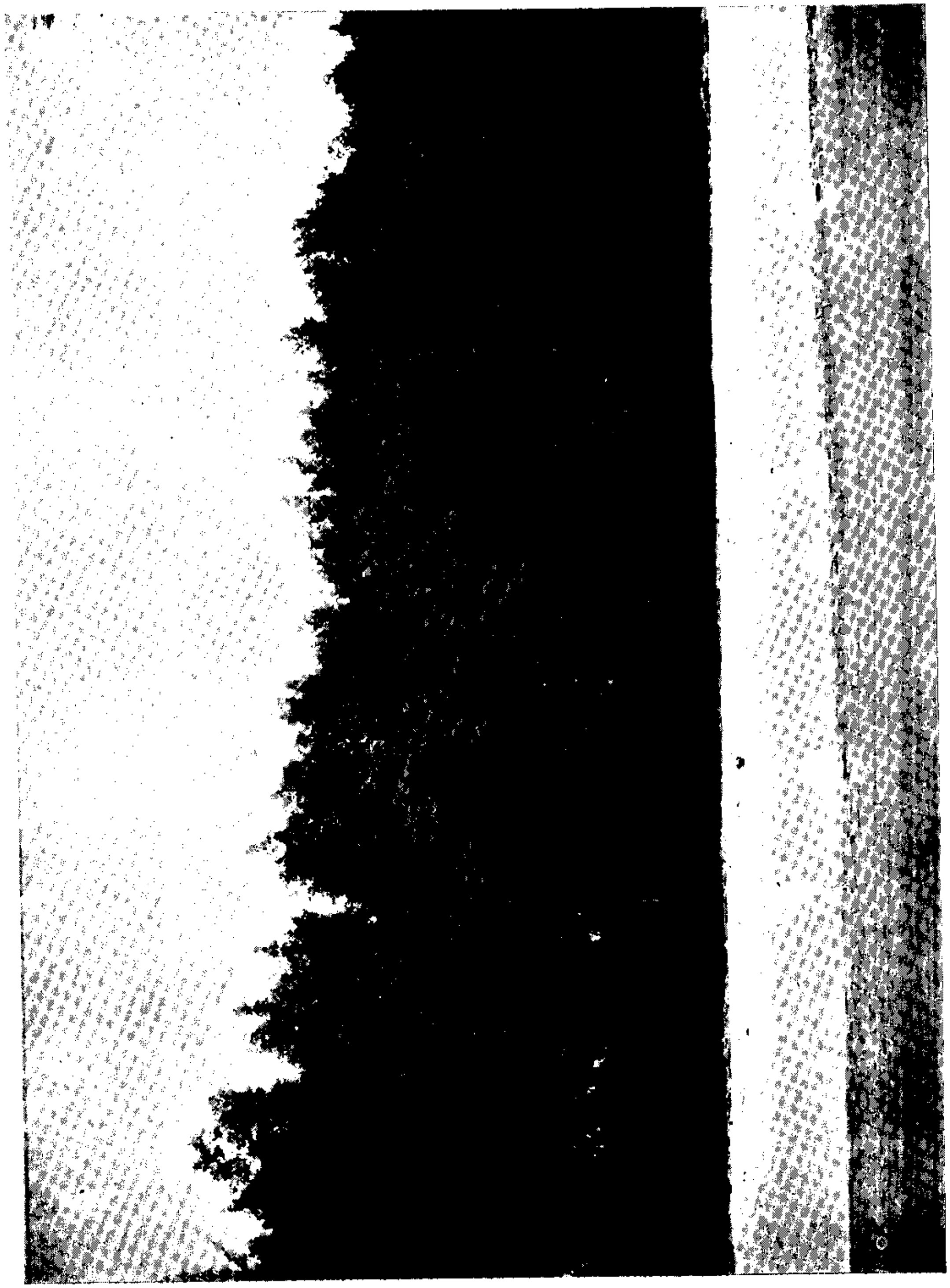
(2) It must have a host-plant on the roots of which it feeds.

(3) Sandal does take up some trees as hosts readily, while others are taken up in varying degrees.

The following is a list of host-plants which were tried with sandal seedlings :

[*N. B.*—One hundred plants were sown with seeds of host-plants and sandal together and the results were noted after the seedlings were 12 months old.]

No.	Gujrati name of host.	Latin name.	Per cent.
1.	*Shevri*	*Sesbania aegyptica*	56
2.	*Ardusi*	*Adhatoda vasica*	40
3.	*Kapas*	*Gossypium arborium*	26
4.	*Thuver*	*Opuntia dillenii*	21
5.	*Aso-palav*	*Polyalthia longifolia*	20
6.	*Medhi*	*Lawsonia alba*	18
7.	*Bordi*	*Zizyphus jujuba*	14
8.	*Sibul*	*Bombax malabaricum*	15
9.	*Ambli*	*Tamarindus indica*	12
10.	*Val*	*Dolichas lablab*	11
11.	*Mahuda*	*Bassia longifolia*	10
12.	*Sisam*	*Dalbergia sissoo*	9
13.	*Aval*	*Cassia auriculata*	9
14.	*Limbda*	*Melia azadirachta*	8
15.	*Kher*	*Acacia catechu*	8
16.	*Ambla*	*Phyllanthus reticulatus*	8
17.	*Aritha*	*Acacia concinna*	8
18.	*Jambu*	*Eugenia jambolana*	8
19.	*Babul*	*Acacia arabica*	6
20.	*Charoli*	*Buchanania latifolia*	6
21.	*Amba*	*Mangifera indica*	4
22.	*Khakhro*	*Butea frondosa*	3
23.	*Sag*	*Tectona grandis*	3



THE PLANTATION AS SEEN FROM A DISTANCE. IT IS 13, 14 AND 15 YEARS OLD. IN FOREGROUND IS THE SANDY SEA BEACH

Photo: K. S. Wagh.

SANDAL TREE 3 YEARS OLD WITH MOGRA AS HOST-PLANT WHICH IS NOW FLOWERING

In the next year, *shevri* (*Sesbania aegyptica*) was grown alone and when it was 3′ high sandal seeds were planted in the same pots. They gave splendid results. The sandal seeds germinate generally after a month and feed on their own food for some time and when their roots come in contact with the roots of *shevri* (which is at this period a very well developed plant with strong root-system) the union becomes permanent and the sandal acquiring new food gets strength and develops. There is another strong reason for selecting *shevri* as host-plant. In this tract (North Gujarat) the summer temperature in May and June goes up to 120°F. while in cold months there is frost and the temperature goes below 40°F. It has been observed that *sandesra* (*Poinciana elata*) is growing naturally in almost all parts of this country. In such a tract of erratic rainfall, which varies from 5″ to 25″ it flourishes and can be easily propagated from seeds and cuttings. Shepherds and wandering tribes use it for making sheds and enclosures. It does not suffer much from excess of cold or heat. Now *shevri* is a cousin of this tree. It is grown in Deccan for supporting betel vine which requires a very cooling and shady tree. Hence *shevri* is selected as a future host-plant for sandal in Gujarat where the land is sandy loam. It may not flourish in black cotton soil of South Gujarat.

Effect of Frost.—In the year 1934 there was a very serious frost and those sandal plants which were unprotected by other trees were all burnt up. But after a month almost all the plants recovered and put forth new growth. It seems frost is not able to kill sandal completely though it may paralyse the plant for a time and retard its growth.

Germination of seed.—Under forest conditions the germination is very poor, about 8 per cent. It falls an easy prey to rats and birds which are abundant in State jungles.

Best season for growing.—The best season for growing sandal is June. The germination is best and the pests, rats and white-ants are not very active at this time.

Age of Sandal.—In North Gujarat this tree grows very rapidly. In a space of three years, it becomes a tree measuring 10′ to 12′ and

begins to flower and bear fruit. The tree shown in the picture (Plate 45) is three years old and is just flowering. The host-plant is *mogra* (a Jassamine creeper) which grows wild in Balaram jungles. The mature trees in Sendhni jungles are 30′ in height with a girth of 36″ to 48″. The tree is considered mature for cutting after 20 years when its oil contents reach the maximum.

Prices Realised.—Some old trees were disposed of in my predecessor's time and the price realised per tree comes to Rs. 40.

New Plantation.—Up to the time of writing these notes about 2,000 plants (now recognised as trees) are standing in various localities of State jungles. It is proposed to go in for a small scheme of sandal plantation in the canal area served by the Ganga Sagar tank. One irrigation square (40 *bighas*) is divided into five divisions. Every year 8 *bighas* will be sown with sandal (10′ × 5″) which will give about 4,000 plants every year. The experimental scheme is for five years and at the end of this period the results will be noted and if found satisfactory it might be extended in future. It is proposed to grow *shevri* first by help of irrigation in the month of May and when the plants are 3′ to 4′ high sandal seeds will be dibbled around the ***shevri*** plants in the month of August. In all four full waterings will be given in a year.

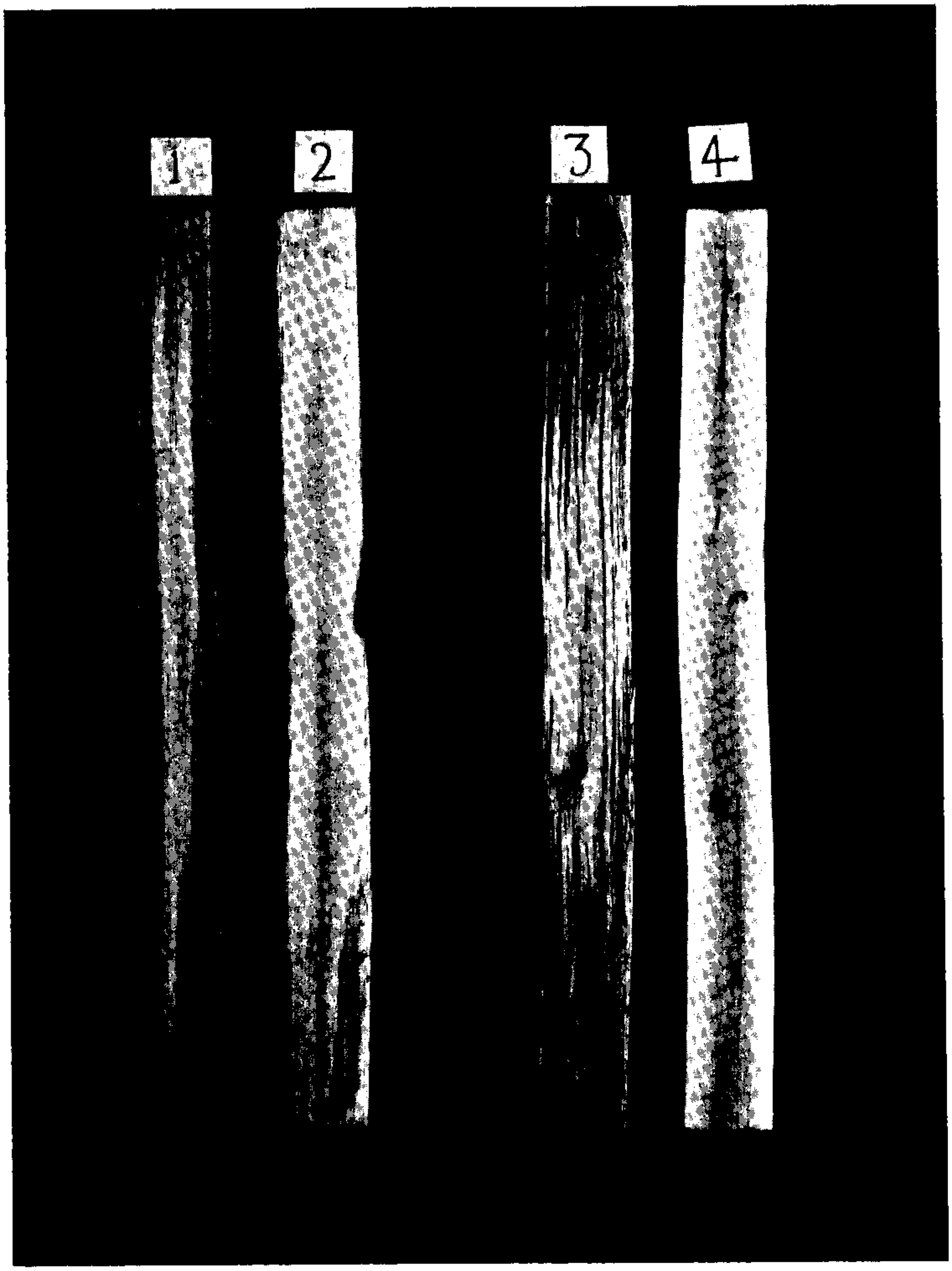
Note.—**We advise the author to read the observations of the Inspector-General of Forests in his inspection note on Coorg on sandal and sandal plantations. [HON. ED.]**

OPEN TANK TREATMENT WITH ASCU

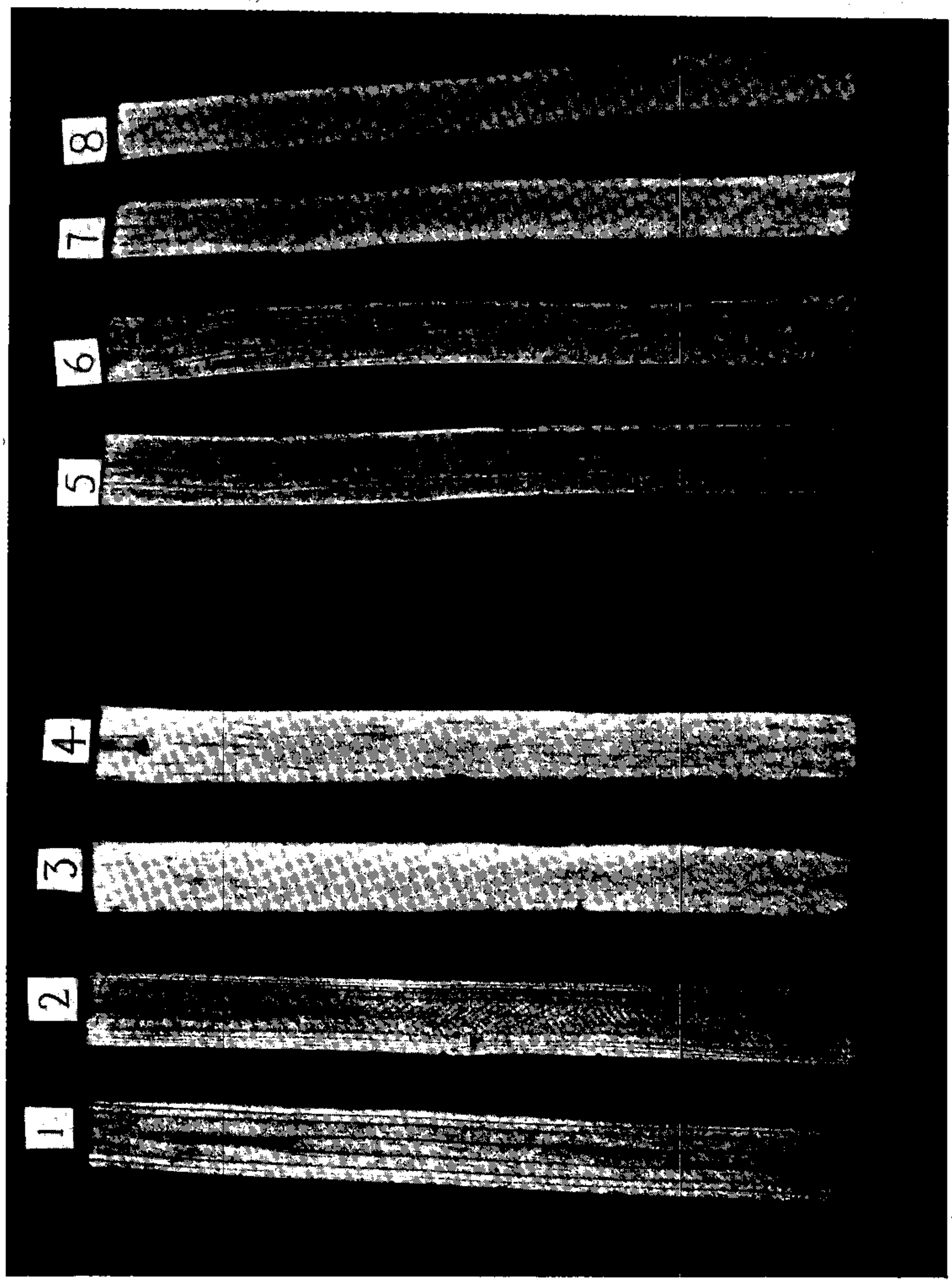
BY *H. TROTTER, I.F.S., UTILIZATION OFFICER.*

From time to time enquiries have been received at the Forest Research Institute as to whether Ascu can be used for what is usually known as an open tank treatment, *i.e.*, soaking wood in a preservative without applying any pressure.

The theory of an open tank treatment is that wood is first heated in the preservative and then allowed to remain in the liquid while the latter cools down to atmospheric temperature. The heating causes the air in the wood cells to expand, thereby expelling a certain



NOS. 2 AND 4 SHOW BILLETS SOAKED IN COLD ASCU SOLUTION FOR 24 HOURS. PENETRATION NEGLIGIBLE. NOS. 1 AND 3 SHOW BILLETS HEATED IN WATER FOR HALF AN HOUR AND THEN SOAKED IN ASCU SOLUTION FOR ONE HOUR. PENETRATION FAIR BUT NOT COMPLETE



NOS. 3 AND 4 (CHIR) AND NOS. 7 AND 8 (SAL) SHOW BILLETS SOAKED IN COLD ASCU SOLUTION. PENETRATION PRACTICALLY *nil.* NOS. 1, 2, 5 AND 6 SHOW BILLETS HEATED IN WATER RAPIDLY FOR ONE HOUR AND THEN SOAKED IN COLD ASCU FOR ONE HOUR. PENETRATION COMPLETE, BUT ABSORPTION TOO HEAVY

amount of air from the wood. When cooling starts, the remaining air in the wood cells begins to contract and this automatically sucks the preservative into the interior of the wood.

It will be seen that heat plays an important part in an open tank treatment, and with creosote and other preservatives, which have to be heated for treating purposes, such a method of treatment can be very efficient, more specially with such woods as absorb preservatives fairly readily (and with the sapwood of practically every timber). Ascu on the other hand has to be used cold, since the heating of wood in Ascu liberates certain constituents (such as tannins) from the wood, which tend to convert the Ascu solution and cause a precipitate.

In a few preliminary experiments done in the Chemical Branch of the Forest Research Institute, it was found that boiling 6 per cent. Ascu, without wood, for an hour, and then cooling for 24 hours, resulted in a precipitate amounting to 0·02 per cent. of the Ascu. This is negligible, but when Ascu was boiled for one hour *with wood in it* and was then allowed to cool for 24 hours, the amount of precipitate increased to **12** per cent. This amount of precipitate is serious, and at once showed the undesirability of using the ordinary method of open tank treatment with Ascu. The question then arose as to how to get over this difficulty.

The first thing tried was whether good absorption and good penetration could be obtained by soaking wood in cold Ascu. Some round sapwood billets of about 3″ diameter of chir pine and sal were therefore soaked in cold Ascu for periods varying from 24 to 45 hours. The absorptions ranged from 6·8 to 9·0 lbs. per c.ft. but the penetration was practically *nil*, the best being about $\frac{1}{4}$″ end penetration and $\frac{1}{8}$″ side penetration. The penetration obtained can be seen in billets No. 2 (chir) and No. 4 (sal) in Plate **46** and Nos. 3 and 4 (chir) and Nos. 7 and 8 (sal) in Plate **47**.

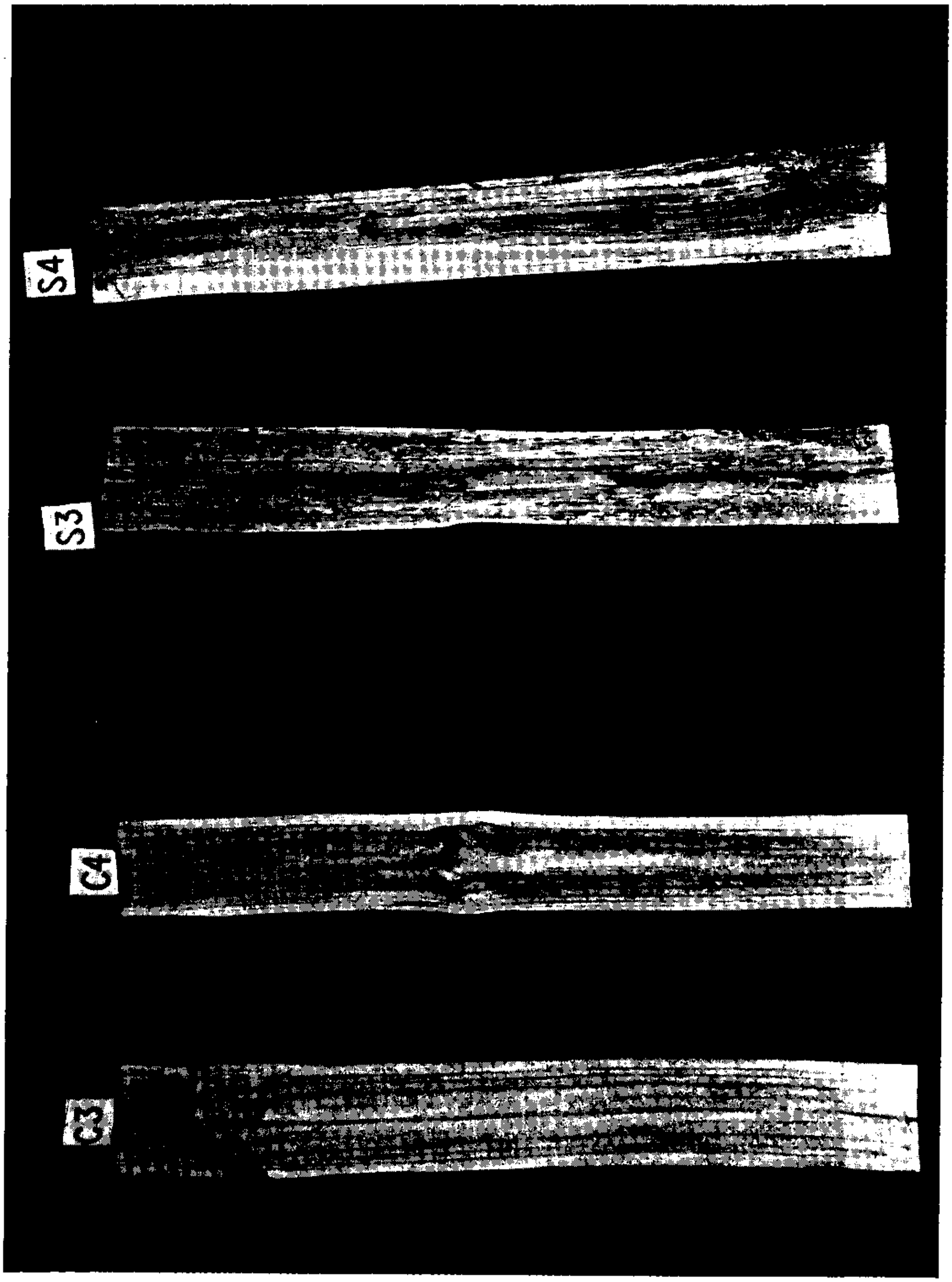
From these experiments it was quite evident that no effective treatment could be obtained by soaking wood in cold Ascu. The problem was therefore to discover some means of heating the wood

prior to soaking it in cold Ascu, so as to get the effect of the " vacuum action " of the cooling wood, but at the same time using cold Ascu.

At the suggestion of the writer two tanks were placed side by side. In one was plain water which could be heated. In the other was cold Ascu. Chir and sal sapwood billets were again used for this experiment. The billets were first placed in the water tank and the water was heated for half an hour (15 minutes up to 98° C. and 15 minutes boiling at 98° C.) to cause expansion of the air in the wood and also to remove some of the water soluble constituents in the wood. At the end of this period the billets were taken out of the water tank and put in the tank of cold Ascu alongside for one hour. The resultant penetration was very hopeful but not complete. It can be seen in No. 1 (chir) and No. 3 (sal) in Plate **46**. The question of the absorption of water by the wood during the boiling process is discussed later on.

A further experiment was therefore tried. In this trial the billets were heated rapidly in the water tank for one hour (15 minutes up to 98° C. and 45 minutes boiling at 98° C.). They were then taken out and as before put in the cold Ascu tank for one hour. The result was astonishing. Penetration was complete throughout the billets and the absorption ranged from 30·2 lbs. to 49·6 lbs. per c.ft. The penetration in this case can be seen in Nos. 1 and 2 (chir) and Nos. 5 and 6 (sal) in Plate 47. Such high absorption is not economical or necessary, and it was obvious that this time we had erred too much the other way. A third trial was therefore made. In this experiment the billets were heated slowly in water for 50 minutes (40 minutes rising to 98° C. and 10 minutes boiling at 98° C.) and were then placed in the cold Ascu tank as before for one hour.

This resulted in practically complete penetration (*vide* Plate 48) but with absorption ranging from 8·0 lbs. to 17·2 lbs. per c.ft., the average for 8 billets being about 14½ lbs. per c.ft. By weighing the billets as they came out of the boiling water and again after soaking in Ascu, it was possible to say how much of the total absorption was water and how much Ascu solution. The absorption of water was about 1½ to 2 lbs. per c.ft. so the actual average absorption of Ascu solution was in the neighbourhood of 12 to 13 lbs. per c.ft.—a very



PHOTOGRAPH SHOWING PENETRATION IN CHIR AND SAL BILLETS AFTER HEATING SLOWLY IN WATER FOR 40 MINUTES AND BOILING FOR 10 MINUTES, FOLLOWED BY SOAKING IN COLD ASCU FOR ONE HOUR. PENETRATION COMPLETE AND ABSORPTION MODERATE

satisfactory figure for an open-tank treatment. By varying the boiling and soaking periods it would no doubt be possible to reduce the absorption slightly if it is considered too high, but, on the whole, the experiment was extremely satisfactory and demonstrated beyond doubt that efficient open-tank treatment is possible by the means adopted. A specially advantageous feature of this " double-tank treatment " is the extraction of tannins, etc., during the boiling treatment. This frees the surface layers of the wood of these chemicals which are partly responsible for the precipitate which is deposited when wood is heated in Ascu, and the heated wood goes into the cold Ascu tank in a fairly clean condition. This does away, to a large extent, with any danger of a heavy precipitate forming in the cold Ascu tank due to hot wood being placed in the solution.

Further experiments were tried on the same lines with chir *heartwood* scantlings, but the penetration and absorption were distinctly poor, and the process is more suited to the treatment of sapwood. For such articles as fence posts and other round timber, the treatment should prove simple and effective, and for those not wishing to purchase a pressure plant, it is a treatment which is very much superior to plain soaking in cold Ascu or to a brush treatment.

Anyone wishing to try it can easily work out for themselves the best times for boiling in the water and soaking in the cold Ascu. These times will vary with different species and different sizes of timber, but one or two experimental runs will soon demonstrate the optimum to give good penetration and good absorption. The experiments done were admittedly on a small scale, but the photographs in Plate 47 show very plainly the tremendous difference between the cold billets soaked in cold Ascu for 24 hours, and the hot billets soaked in cold Ascu for 1 hour, and the idea of a " double-tank treatment " is recorded in this short article with the notion that it may be of use to those who wish to treat wood efficiently with Ascu, but have no other means of doing it.

A NOTE ON THE BRIDGE OVER THE RAMGANGA AT KALAGARH

BY R. N. BRAHMAWAR, I.F.S.

Approximately three-quarters of the forest produce of Kalagarh division is exported along the Ramganga valley road to Dhampur. At Kalagarh the loaded carts had to cross the river (a width of approximately 323′ stretch of flowing water at the commencement of the working season) with difficulty varying with the water in the river. The river crosses the submountain Kandi road at Kalagarh. There is always a lot of traffic along the road. The depth of water did not permit motoring across the river except for a short time about the end of the hot weather so that motor cars from Kalagarh proceeding towards Ramnagar had to go up to Boxar and down again by another road covering a total distance of 14 miles to be able just to go across the river opposite Kalagarh. Considering all these the necessity of a bridge at Kalagarh had been keenly felt, all the more when roads in the forests had been improved to permit motor traffic and the formation of the Hailey National Park is going to result in keener demand for greater facilities for motoring.

The construction of the bridge was therefore decided upon but due to financial stringency very limited funds were available. The requirements for the bridge therefore were :

(1) Low initial cost.
(2) Low cost of upkeep and of re-erection in future years.
(3) Safety. The bridge should be strong enough for heavy loaded lorries to pass over in safety and for regular heavy traffic of loaded carts and camels.
(4) Easy to erect and dismantle at short notice.
(5) Simple in design so that there be no possibility of error when erected by local illiterate contractors or under lower subordinates.

Keeping in view the above requirements the bridge shown in photograph No. 3 (Plate 50) was erected at a cost of Rs. 520 to span a width of 323′ ; the height of crib piers averaging a little over 5 feet,

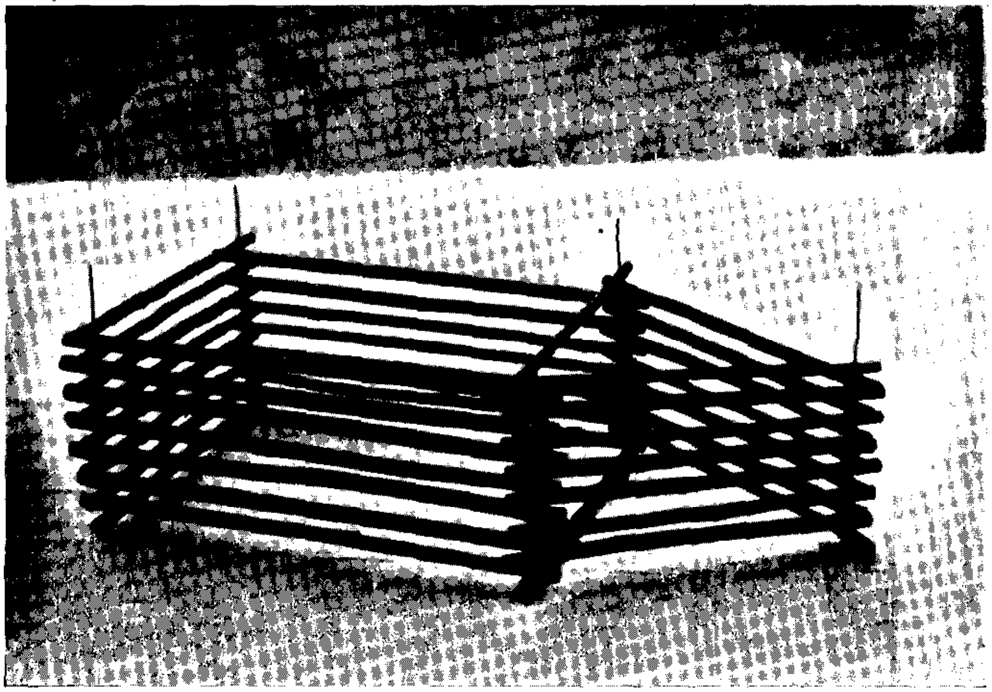


Fig. 1
SHOWS THE SHAPE OF THE CRIBS

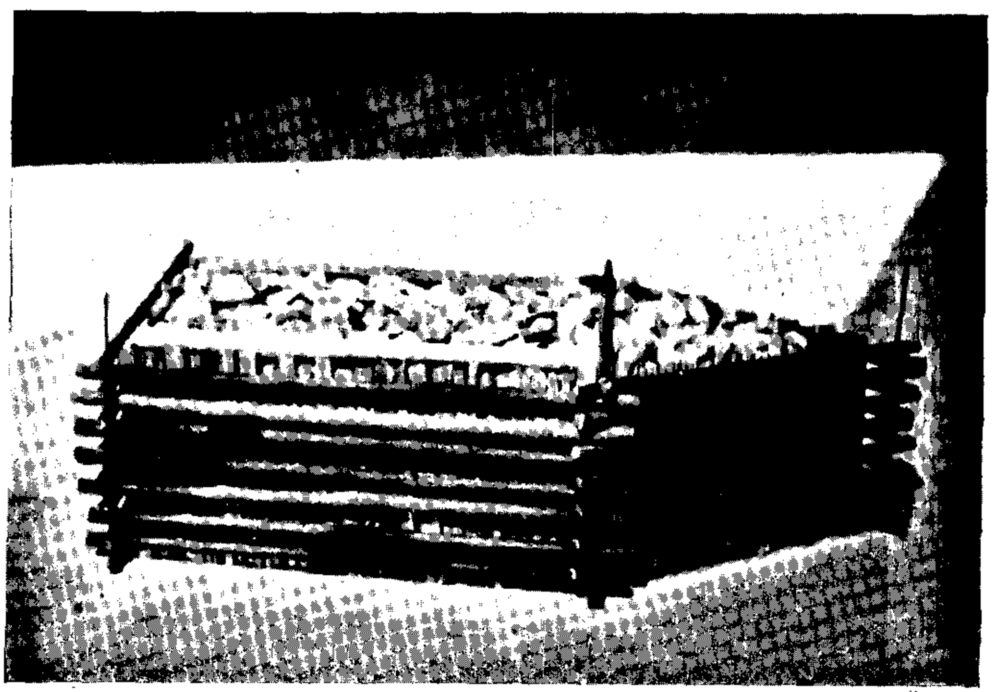


Fig. 2
SHOWS THAT TOP LAYER WAS LEVELLED AND WALL PLATES PLACED TO SUPPORT ROAD-BEARERS

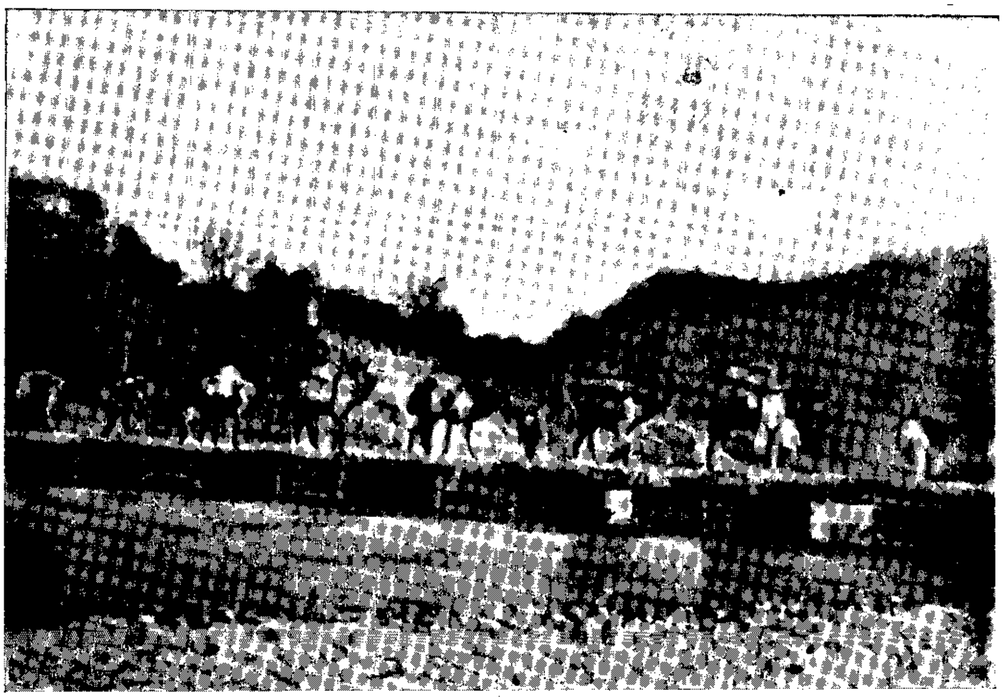


Fig. 3

BRIDGE ERECTED AT A COST OF RS. 520 TO SPAN A WIDTH OF 323 FEET

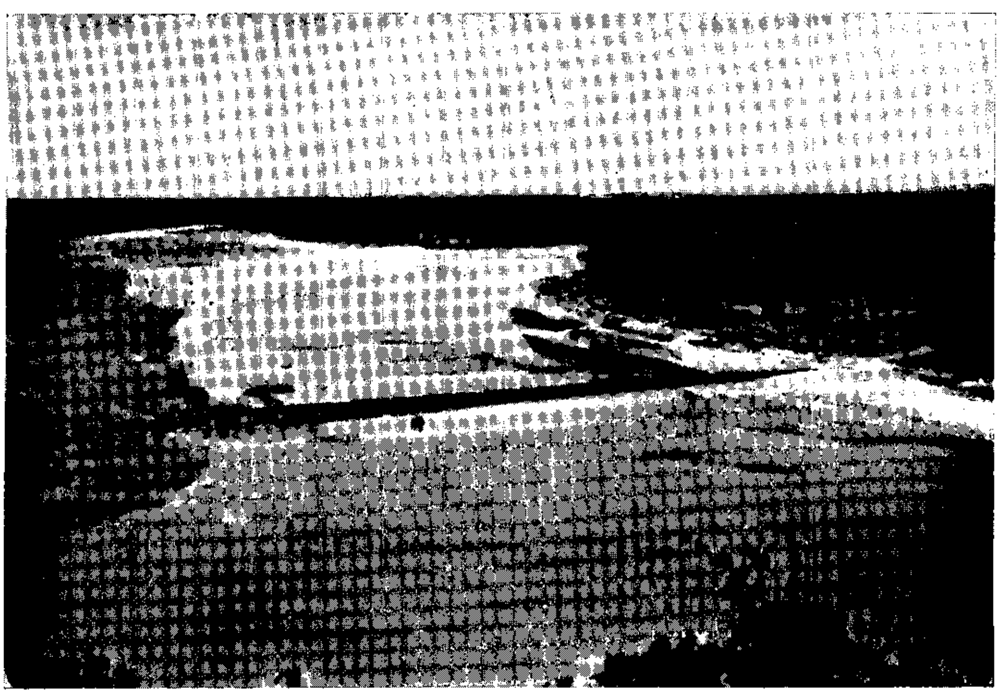


Fig. 4

A CLOSER PHOTO OF THE CRIBS AND THE BRIDGE OPENED TO TRAFFIC

The material required for the crib piers was sal wood *tors* (axed round timber with sapwood removed) of lengths 9′ and 13′ and round iron bars 5′ and 6′ long and 1″ diameter.

Holes of 1½″ diameter were bored with an auger near the ends of the *tors*, the distance between the holes being kept at 12′ centre to centre for 13′ long *tors*, and 8′ centre to centre for 9′ long *tors*. These distances between the holes may be kept as desired but once decided upon should be kept accurately constant if trouble-free erection is to be ensured. For this a split bamboo with small holes bored was used as a measure to mark out the centres of the holes in *tors* and with this an ordinary carpenter found no difficulty to attain accuracy.

The actual erection of cribs was very easy. The end cribs made just outside the water line were rectangular. Two 9′ long *tors* were placed at right angles to the direction of the current at 12′ distance. Across these were placed the longer 13′ *tors* so that their holes were just above those of the shorter *tors*. Four iron bars, one at each corner, were then passed through the holes and hammered down to a small depth in the river bed keeping these in a vertical position. Alternate pairs of 9′ long and 13′ long *tors* were then lifted up, the iron bars passed through the holes and the *tors* lowered down to rest on the previously fixed *tors*.

For the cribs in between the end ones, the main body of the crib was rectangular but a triangular projection was added to break the force of the current. Photograph No. 1 (Plate 49) clearly shows the shape of these cribs. As before two short *tors* AB and CD were placed at a distance of 12′ followed by two long *tors* and iron bars passed through the holes. After this a 9′ long *tor* was fixed over AB while on the other side upstream an iron rod was placed at E, 8′ from the points C and D and two *tors* 9′ long CE and DE were passed through iron bars at C, D and E. Subsequently two long *tors* were fixed alternating with three short *tors* as before. The final pair of two short *tors* acts as wheel guards.

The framework of a crib can be erected in about 20 minutes.

As the bed of the river is not always level, any of the corners can be raised by first placing a block of wood of requisite thickness

through which the iron bar is passed. In practice some of the *tors* are received longer than necessary and their ends are cut off to make the *tors* to proper length. The cut-off ends are quite suitable for raising any of the corners for levelling the cribs. In any case one such piece is required at E.

A layer of splitwood from miscellaneous species was then laid against the *tors* on the inside of the cribs and these were then filled with river boulders. The top layer was levelled and wall plates placed to support road-bearers. (Photograph No. 2, Plate 49.)

Sal and miscellaneous poles were used as road-bearers, 8 to 10 side by side per span. Splitwood and grass was spread across the road-bearers and a top dressing of sand and small gravel completed the road surface.

The bridge had 15 cribs, with spans 13′ to 14′ except a middle span 18′ to permit bamboo rafts to pass under the bridge. The total length of the bridge including the approaches was 383′ and excluding approaches 323′. The cost incurred is as follows :

	Rs.	a.	p.
(1) Cost of 80 iron bars (73 only used)	59	9	0
(2) Railway freight and carriage to the site ..	43	4	0
(3) Cost of sal girders and sal *tors*	83	0	0
(4) Carriage of the above	93	4	0
(5) Girders of miscellaneous species	42	0	0
(6) Boring holes in *tors*	12	12	0
(7) Erection of 15 cribs and splitwood on the sides to hold boulders	22	8	0
(8) Walls for approaches and filling in between and filling boulders in cribs, 8,564 c.ft. at 1/8/-% ..	128	7	0
(9) Splitwood and grass over girders and top dressing of earth and small gravel..	30	0	0
(10) Contingencies	5	4	0
Total ..	520	0	0

If the timber (*tors*) had been purchased from contractors at current rates instead of preparing departmentally an increase in cost by Rs. 50 should have occurred. On the other hand suitable boulders that are usually found at site had this year to be brought from long distance and in normal years a saving at least of Rs. 50 should have resulted under item (8) above. The above amount (Rs. 520) therefore represents the correct cost.

The cost of dismantling and re-erection in future is estimated as follows:

	Rs.	a.	p.
(1) Renewal of sal *tors* (maximum average 10%) to be purchased from contractors	25	0	0
(2) Girders—miscellaneous species	30	0	0
(3) Erection of cribs	22	8	0
(4) Filling cribs, approach walls and filling in between	100	0	0
(5) Splitwood and grass over girders and top dressing of earth, etc.	30	0	0
(6) Contingencies, say	7	8	0
	215	0	0
(7) Cost of dismantling at the end of the working season and storage of timber	10	0	0
Total recurring expenditure ..	225	0	0

While no great skill is claimed for evolving the type of bridge, it fulfils all the requirements, *viz.* low initial and recurring cost, simplicity of design combined with adequate strength. The iron bar passing through the *tors* is never likely to be subjected to a shearing force enough to cut through the 1″ diameter bar. The force on the *tors* is very small and due only to the side thrust of a layer of the round boulders next to the *tors*. The force of the current varies and though when Ramganga is in floods such temporary bridges cannot be expected to stand against it, the bridge in fact has been tested under the extraordinary floods of 11th February 1937

when two very strongly built standardised bridges were damaged and two ordinary bridges completely washed away. The approaches of the Kalagarh bridge wallings and fillings were also washed away and due to the knocking of bamboo rafts against the cribs (57 rafts washed away in the floods) the projecting iron rods were bent, the cribs, however, remained intact. It shows that the bridge may be strong enough for normal requirements.

Photograph No. 3 (Plate 50) shows a bird's-eye view of the bridge; No. 4 is a closer photo of the cribs and the bridge opened to traffic.

SUPPLEMENTARY NOTE BY MR. E. A. SMYTHIES, I.F.S.

This cheap but serviceable bridge withstood an exceptionally heavy cold weather flood in February 1937, when a number of large bamboo rafts and other flotsam and jetsam jammed against it.

The flood topped the bridge, washing away some of the road surface and approaches, but beyond bending one or two of the iron bars, no damage was done to the structure of the bridge itself. This was an exceptionally severe test, and Mr. Brahmawar deserves great credit for designing and erecting a cheap bridge to withstand it successfully.

ARCHAIC FOREST TERMINOLOGY

Language is a mysterious organic thing, ever reaching out to fresh expressions and discarding old ones as silently and unobtrusively as a tree flaking off its bark. The new and audacious word of to-day becomes to-morrow's commonplace. In forestry, we have our " recruitment " and " seeding " years, our " whips " and " pre-germination beds," nursling expressions that would raise the bushy eyebrows, if not the wrathful questioning, of past generations of Conservatorial giants. But let us, in turn, have our laugh over the phraseology current amongst those older age gradations.

One Buchanan—not actually a forest officer, for I quote him in the year 1813—writes of " ligneous plants. " The expression sounds wooden enough to the modern ear. A Public Works Department

report of 1869 talks of forests " which are too closely packed " and of trees having " clean barks and fine heads ; " may be the conscientious compiler was a dog lover. The august Brandis, as I. G. F., refers to " maiden " trees, *meaning with Victorian niceness rather* than nicety, trees arising from seed as opposed to coppice ! There is more than a trace of Victorianism, too, in his saplings " sound at heart " and in a near contemporary's " unsound and languishing " class II stems. A little later we find Beadon Bryant deploring a *forest having been " bullied," an old-school-tie expression unlikely* to bring a blush to the exploiter's cheek.

Nearer to our time, Fisher (1898) writes of " calculations of the capability, " a pleasing alliteration that the War generation has dropped. Let us, however, keep all the capability we can muster and so prove ourselves worthy descendants of those pioneers of our craft.

F. R.

STALKING BARAL IN THE UPPER BASHAHR FOREST DIVISION

BY *HARI SINGH*, P.F.S.

The baral (*Ovis nahura*) is one of the most coveted trophies of the Upper Bashahr forest division in the Punjab. This division, which is situated for its greater part in the inner Himalayas, is remote from civilization. Apart from its sparse and primitive population, very few travellers ever penetrate into its desolation—it commands a vast expanse of country, rich in game. Himalayan ibex, thar and red bear may be mentioned in addition to baral.

Immediately on joining this division baral occupied the uppermost place in my mind. This mountain sheep is unquestionably very difficult to approach and to shoot, and those who venture into the wild and dangerous regions in pursuit of this wily animal have to be well equipped with courage and endurance. Gifted with keen

vision and a highly developed sense of smell, the baral seems to have a sixth sense by which he will defeat the most careful stalking. To him man is public enemy No. 1, and he sniffs danger in every tainted breeze. With the slightest suspicion the whole herd will vanish quietly as though into an ethereal mist.

Apart from a few *shikaris*, snow leopards and avalanches may be included in the list of their enemies ; the latter two taking a heavy toll every year.

Their vertical migration varies from 10,000′ upwards up to the grass limit which in many cases is 17,000—18,000′. With the receding snow in summer they vanish into the high and bleak mountains where the only growth is coarse grass and straggling juniper on which they thrive. With the first fall of snow in October, when the high level grass dries up, they make their downward move. From the nature of their habitat the baral may live a long time without ever seeing a human being.

With such characteristic habits the pursuit of so elusive an animal demands not only a sure aim, but all the qualities of the practised mountaineer whose constitution is proof against the rigors of a severe climate. Unfortunately the latter quality is somewhat at a discount in my case. But being so favourably stationed and so interested in the tales of daring exploits on the highest and wildest mountain peaks, told by the old local veterans, I felt the love of wild sport too strong to resist.

Immediately after the expiry of the usual close season, and having gathered locally the necessary information as to the best hunting ground, the first week of October found me plodding up the beautiful valley of the Baspa river, with a brief but indispensable outfit. This river, which separates the famous and holy Kailas mountains from the Dhauladhar range of the Great Himalayas, flows into the Sutlej three miles above Kilba (6,500′)—my headquarters. The vegetation along this valley is characteristic of the transitional belt between the wet and the dry zones. *Pinus gerardiana, Quercus ilex, Fraxinus xanthoxyloides* and *Olea cuspidata* cover the lower slopes, while higher up *Cedrus deodara, Pinus excelsa, Picea morinda,*

Abies webbiana and *Betula utilis* occupy their respective belts. Amongst the shrubs *Plectranthus rugosus*, *Daphne oleoides* and *Artemisia* spp., deserve mention. From the Raturing Obstruction up to its confluence with the Sutlej (8 miles), the Baspa river cascades through a deep forest gorge, but beyond Raturing the narrow valley ends abruptly and then expands to form one of the most magnificent beauty spots in India, if not in the world. Its picturesque, flat and fertile fields, dotted with beautiful green walnut trees and comfortable but primitive huts, is a memory to be treasured. As we proceed up the valley the trees become more and more stunted and gnarled, gradually and imperceptibly, till at about 12,000′ they disappear altogether. Straggling birch forest marks the last stage of tree growth. It is from this place onward that we begin to look for our quarry whose habitat extends throughout the valley to the Tibetan border.

Three days march from Kilba brought me to the last grove of birch along the right bank, 9 miles further up the valley from Chhitkul—the last village. Here the climate is very cold and militates against any agricultural pursuits except the grazing of sheep and goats. Chhitkul is 28 miles from Kilba which in turn is 129 miles from Simla, thus making a total trek of 166 miles, every inch of which has to be covered either on foot or on a pony. It is interesting to note here that baral are plentiful in the hills on the right bank of the river, but on the left they are almost entirely absent.

I was up betimes the morning following my arrival in camp, after a fair night's sleep on a bed of boughs. The atmosphere was crisp, pure and exhilarating. The sky was deep blue with here and there a feathery cloud gliding lazily over its surface. The conditions being ideal, I set off after my quarry at dawn taking with me two local guides.

At 10 o'clock, when we reached 14,000′ no game had been sighted although fresh baral spoor had been seen. Feeling somewhat tired, I passed on my rifle to one of the men, as I felt it to be an unnecessary encumbrance till the quarry was seen.

At about 11 o'clock suddenly one of the guides sank slowly to the ground and, as we followed his example, I noticed two baral grazing in a shallow corrie above. I immediately grabbed my rifle and under cover of a rock commenced stalking, an undertaking which was exacting to a degree and back-breaking almost past endurance. When my hard labour for about an hour placed me within shooting range and I raised my rifle to enjoy the long waited shot, I found the place absolutely deserted. They had already disappeared as though into thin air. It so happened that when I was half way up after sighting them, a gentle breeze had placed them on my lee, and on getting my wind they quietly slipped away. My disappointment can be better imagined than described. I beckoned to the men who on joining me remarked that it was only my ill-luck that had prevented me from obtaining a good head.

We continued working uphill until we reached the grass limit (about 17,000′). Above this the country was strewn with broken shale, and there was no possibility of finding any game. Tired and weary to the last degree we flung ourselves on the ground for a breather. At about 2 o'clock the clouds began to gather and being threatened with drizzle and sleet we commenced our downward journey through a more promising tract. Hardly had we descended a couple of thousand feet when we caught sight of a flock of baral resting in a side nalla. It is the habit of this animal to enjoy a few hours' rest in the day between 12 to 4 o'clock after he has fed well, and while the rest of the herd is asleep, the sentry remains ever watchful for any possible enemy. A long but unpleasant crawl on a steep stony slope brought me within about 300 yards of them. Further stalking was impossible without exposing myself to their sentry. One of the guides who was sharing the brunt of stalking with me advised not to take a chance from such a long distance. Evidently he was used to the old muzzle-loader capable of pasting the victims from short distances. As he was busy administering admonitions, " bang " went the 235 grain bullet from my ·375 Magnum. " Over him," was the quick whisper. The whole flock—nine of them- huddled together in confusion, giving me another

golden chance. The second shot evidently went home. One of them began to sway and finally collapsed, the bullet taking it through the heart. The sentry suddenly started galloping uphill with the rest of the followers, but before they disappeared I emptied my magazine. One more broke off from the rest, tried to balance himself for sometime and then a heavy thud announced his arrival at the bottom of the chasm below. It was now five o'clock and with great difficulty we managed to carry only one to the camp, leaving the other to be fetched the following morning. Weary to the bones we reached camp at about 8 p.m., where a comforting birchwood fire greeted us.

FOREST POCKET BOOK

BY S. H. HOWARD, I.F.S.

4TH EDITION, 1937

(*Price Rs.* 2-4-0, *Superintendent, Printing and Stationery, Allahabad, U. P., India.*)

Mr. Howard must feel justifiably proud of having brought out the fourth, revised, and enlarged, edition of his Forest Pocket Book to meet the growing demand amongst forest officers as well as the general public for this book. This handy little compendium (small enough to be slipped into any tunic pocket) was first published in 1927 and the call for its second and third editions came within a year of publication which indicates its immense popularity. Although much progress has been made in all branches of Forestry since the last edition was published in 1928, the author was of the opinion that a complete rewriting of the book was not absolutely essential at this stage. Accordingly, " suggestions which necessitated entirely fresh work have been omitted, while those which consisted in revision or expansion of old work have been included." It is interesting to note that the silvicultural parts of the pocket book have been translated into Hindi.

The older editions had provoked considerable interest and a comprehensive review was published in the *Indian Forester* for December 1927.

The general get-up remains as attractive as before. No new item has been included under the chapters on Artificial Regeneration, Important Species, Miscellaneous Silvicultural Matters, Engineering, and Miscellaneous (General). The greatest addition has been made in the yield, volume and outturn tables under Chapter IV, where half a dozen more species have been added, *viz. Bombax malabaricum, Holoptelea integrifolia, Pinus excelsa, Quercus incana, Trewia nudiflora* and *Acacia catechu*. Under Chapter V on Utilization, there have been two useful additions on " Ascu Preservative " and " Specifications for Wooden Poles." All these addenda are the results of work at the Forest Research Institute, Dehra Dun, which the author has thankfully acknowledged. Notes on " Poisonous Snakes " under Chapter VII have been considerably improved upon and rewritten by Mr. Shebbeare. The section on " Forest Telephones" has purposely been omitted, but in its place the inclusion of a very short note on Forest Photography would have been useful.

Mr. Howard modestly called it " a short text-book for rangers " but, as it has brought practically all " the salient points into a compact form," all classes of forest officers have found it both interesting and illuminating as a practical guide to major forest operations. It is an invaluable companion to the average forester and should be his constant companion in the forest.

J. N. S. G.

RESISTING DROUGHT

By R. J. Van Reenen, B.A. (Government Printer, Pretoria).

The author has served on the now historic South African Drought Investigation Commission and is Chairman of the Irrigation Commission for the Union of South Africa, so he can speak with great authority on this subject. The object of this book is to place before farmers and teachers the findings of the Drought Investigation Report which is now out of print and is in any case too voluminous for the layman to tackle. The book explains very clearly the various

phases of drought and its causes, and emphasises the lesson which is so very badly needed in India, namely, that the root cause is not so much vagaries of climate as a gross misuse of the land. South Africa is largely a pastoral country so the major share of the blame is put down to continued overgrazing or overstocking, which has slowly but surely destroyed the plant cover and introduced a fatal regime of accelerated soil erosion.

Other phases of farming affected by scarcity of water are also discussed and many interesting statistics are quoted. Some of the most convincing are those showing the disastrous rate at which expensive reservoir projects are being silted up and rendered useless through the dumping of silt washed off the overgrazed pastures. He pleads with the individual farmer not to wait for Government to act, but to do each what he can on his own land to stop the evil and conserve the soil, which is the farmer's intrinsic and basic resource. This is advice which can be equally well presented to the Indian cultivator.

R. M. G.

FORESTRY YEARBOOK ISSUED BY THE INTERNATIONAL INSTITUTE OF AGRICULTURE

INTERNATIONAL STATISTICS OF FORESTS AND FOREST PRODUCTS

Given the close connection between agriculture in the widest sense and forestry, the International Institute of Agriculture at Rome has always paid special attention to the latter. The Assembly-General of 1922 laid particular emphasis on the importance of an international service of forest statistics and invited the competent organs of the Institute to gather the necessary materials from the various countries in order to complete, unify and centralise such statistics. The first publication of the Institute on forest statistics appeared in 1924 under the title of *Forest and Forestry Statistical and other Information for certain Countries*. The essential data from 22 countries (17 European, Canada, the United States, Japan, Algeria

and French Morocco) were collected to form the basis of an international forest statistics. From the beginning the great difficulties of such statistics, given the diversity of the respective national statistics and often the imperfect definition and classification of the data, were apparent.

In view of the growing interest of Governments and students, as was clear from the resolution of the First World Forestry Congress in 1926, the International Institute of Agriculture undertook a series of preparatory enquiries for the purpose of eliminating the obstacles to international forest statistics. Since students may obtain forest statistics only with much difficulty and the consultation of numerous publications, often difficult of access, the Institute decided to publish the existing data, even with the unavoidable gaps. It did this also with a view to shedding some light on these very gaps in order to enable them gradually to be filled and, on the suggestion of the Agricultural Economic Committee of the Institute at its session of Statistics for 1929-30 and in that for 1930-31, there appeared in an appendix forest statistics for 20 and 30 countries respectively. The statistical data, collected for the most part from Government departments, were published by countries but regrouped according to a prearranged plan to enable them subsequently to be brought together easily in a general table. In these two preparatory publications the trade in wood was not taken into account.

The available forest statistics are gradually increasing so that in 1932 there were statistics for 52 countries in some year near 1932. At the same time there were also compiled statistics of imports and exports of wood for 18 countries during the eight years from 1925 to 1932. In this relatively favourable position the International Institute of Agriculture decided to publish the first International Yearbook of Forest Statistics in 1932. In this Yearbook there appear for the first time general tables comprising a large number of countries and referring to (1) the area of forests; (2) the distribution of forest area according to classes of holding; (3) the distribution of forest area according to species; (4) the growth and production of wood by year and (5) trade in wood.

The material collected for the second Yearbook is already so rich and the experience acquired in the utilization of the data has so much grown that the number of general tables has increased to such an extent that it has become necessary to publish several volumes. The first volume of the International Yearbook of Forest Statistics for 1933-35 has already appeared and includes all the European countries and the U. S. S. R. The statistical data collected and elaboration in this volume are grouped in two large classes, namely, forest statistics and statistics of the trade in wood. Each of these classes is sub-divided into two sub-groups ; general tables and detailed tables. The basis data of the Yearbook are, of course, those given in detail for the different countries for forests and for wood trade. Of the 327 pages, almost 100 are devoted to forest statistics and another 100 to imports and exports, while the remaining pages are devoted to general tables. The forest statistics of the different countries refer, as far as the national statistics allow, to the following subjects: the extent and composition of forest lands, ownership and management, distribution of forest according to species and age, volume of wood existing in the forests, annual growth and production of wood. In some countries there are also other special data. The data for trade in wood include all the more important rubrics of international trade expressed in metric tons and for the more important, in cubic metres, for the period 1930-34 (1930-35 in the general tables). Given the great diversity of the units of measurement, a great many reductions have to be made. Tables of the coefficients used for this purpose precede each chapter in the trade section in order to aid the reader in making comparisons. The indication of sources at the end of each table of forest statistics for the different countries is of the greatest utility to the student.

With the Forestry Yearbook of 1932 and the first volume of the Yearbook for 1933-35 what will no doubt be a long series has been successfully begun and these Forestry Yearbooks, becoming increasingly accurate and complete, will give an exact picture of silviculture in the different countries. The International Institute of Agriculture, while publishing the Forestry Yearbooks, continues its work of

perfecting and unifying forest statistics, collaborating for this purpose with the International Institute of Statistics and the Committee of Statistical Experts created under the International Convention for Economic Statistics of 1928.

EXTRACTS

AFFORESTATION FOR VILLAGES IN THE PUNJAB

BY R. MACLAGAN GORRIE.

Dr. R. Maclagan Gorrie, Indian Forest Service, in the course of the broadcast talk on "The Punjab's Fuel Supply," from the All-India Radio, Delhi, on Monday, said :

Many years ago an officer, named McConochie, who was Deputy Commissioner of Gurgaon, decided that as a punishment a certain offender should create a forest *rakh* by enclosing and protecting some of his own waste land. Twenty years later this same man sold the wood from this *rakh* as fuel and from the proceeds married off both his son and his daughter. It is a pity that all magistrates' sentences are not as productive of good as this one was.

What do we need fuel for ? Could we not get on quite well without it ? In the cold Punjab winter those who can afford it use a fire for warming the room, but even the poorest in the land need fuel all the year round for cooking. In addition to ordinary cooking, milk has to be kept hot all day and other dishes such as *dal* and *gowara* have to be kept simmering for long hours. In the towns charcoal from wood and Bengal mineral coal are being used and very large quantities of cow-dung are burnt, but for ordinary household cooking wood is always necessary. The wood supply is precious because there is so little of it and the easiest substitute is dried cow-dung. It is a common sight almost everywhere in India to see these dung cakes drying in the sun.

FARMYARD MANURE.

Many a time in the course of touring I have asked villagers why they burn cow-dung instead of using it for their fields and the reply is always the same : "Sahib, we know it ought to go to the fields, but we must have something to burn."

The bad effects of the burning of cattle manure are not fully realised. Farm crops cannot be grown without constant manuring and, if the fields are deprived of this source of plant-food, they will

deteriorate from year to year and produce crops poorer both in quantity and quality. The best manure of all, and the only one readily available to the Indian farmer, is farmyard manure. When this is used for burning, the fields are starved. The agriculture of India can never be put on a sound footing until this destructive and wasteful habit has been stopped and the manure is used to enrich the soil.

But the burning of cow-dung cannot be prevented unless the villagers have a cheap and plentiful supply of wood to burn. This surely is an excellent reason for starting village plantations, which will produce wood fuel and so save the cow-dung for its proper use as *the food of the soil. If the earth is deprived of her food, she will* no more do her work than men or cattle if deprived of their food, but there is a simple and effective cure, namely, the creation of village forest plantations.

Another source of fuel is the collection of straw, twigs and weeds. This burning of vegetable rubbish is another wasteful habit, because it would be put to far better use in the compost pit to increase the manure supply.

A real economy in the use of all fuel is the hay-box. This is a grand means of keeping milk and other food hot for many hours. The only fuel wanted there is to bring things to the boil before being popped into the hay-box.

CHARCOAL.

To turn to the charcoal supply, it is not every wood that makes a good charcoal. Of the hill forest trees, the pines and firs make poor charcoal and only the oaks are good. Of the plains species, shisham makes probably the best charcoal in the world and kikar and mulberry are also very good, so this explains why it is easier to get good charcoal in the plains than in the hills.

The charcoal supply for the larger hill stations is often brought very long distances by the charcoal burners themselves and sold so cheaply that it is difficult to see how those people can make a living.

In the canal colonies the early settlers had a supply of wood at hand in the slow-growing thorny *jand* and *phulai* trees of the scrub jungle, which had to be felled to make way for the new fields and farms. This supply gradually became exhausted as the virgin soil was brought under the plough. The present supply comes from the last relics of this thorn scrub, but it is not sufficient for the growing population, so that any roadside or canal-bank trees which are sold fetch a high price. In these canal colonies the Forest Department has made several plantations where trees are grown as an irrigated crop in just the same way as cotton or sugarcane, except that it takes several years to produce a crop of wood.

INTERESTING HISTORY.

These plantations have an interesting history. The first was started at Changa Manga in 1866 to grow firewood for the locomotives of the newly built railway to Multan and, after experimenting with many different trees, success was obtained with shisham. This found a good market both for timber and fuel.

Forty years ago, however, mulberry invaded the place and spread like a weed; the more it was cut down the better it grew. It was considered worthless until an enterprising Punjab Captain of Industry, Sirdar Ganda Singh Uberoi, thought of trying it for hockey sticks. It has now surpassed shisham in value and is the mainstay of the flourishing sports goods manufacture of Sialkot.

Most of the plantation output continues to be used as firewood and this forms the main supply for Lahore and Amritsar. This plantation yields a profit to Government of about Rs. 12 per acre per year and has already paid for itself several times over, which shows that even in competition with farm crops, wood is quite a paying proposition.

DAMAGE BY GRAZIERS.

Without the help of irrigation the growing of firewood is, of course, a slower business and in most of our foothill jungles the firewood is greatly reduced by the graziers, who ruthlessly hack and lop

trees to the very top in order to obtain food for their goats, sheep, camels and buffaloes. When a tree has been deprived of its leaves and reduced to a bare and mutilated trunk, one can hardly expect it either to put on any fresh growth of wood or to protect the soil in its vicinity.

Nature uses trees to keep the soil in the condition of a sponge, so that forest soil is capable of soaking up and storing a large proportion of the rain which falls upon it. However, if the plants on the ground are constantly grazed and the tree-tops are cut away, the forest can no longer function in storing water and increasing seepage to the deeper layers.

It should be realised that the production of timber and firewood cannot be satisfactorily combined with grazing ; in fact, uncontrolled grazing is the very worst and most uneconomic use to which any forest can be put. Proper protection against grazing is essential if any plantation is to succeed. This is not to say that the domestic animals will not profit from such closures; on the contrary, the supply of cut fodder, both of grass and the leaves of edible trees, is much better from a protected plantation than from the same ground under common grazing.

Chief Objections.

The chief objections to the planting of trees in village lands are : first, that no land is available for planting; second, that the villager cannot afford to plant trees ; third, that the shade of trees injures his crops.

To deal with each of these. First, the land for planting. There is no doubt that the zamindar has not enough plough land for his needs, but in most villages there is a large area of grazing common which is practically unproductive at present because it serves to keep alive a large herd of miserable thin cattle, useless because they give neither milk nor work, and merely rob the more thrifty cattle of their ration. If a third or even a tenth of each village grazing common was planted with trees, it would produce not only firewood and

timber, but also a better supply of cut fodder. What is required is not more land, but a more intelligent use of the land already there.

COST OF PLANTING.

Second objection—the cost of planting. The trees can be grown by sowing seed direct on the ground, or by growing small plants in a nursery until they are ready for transplanting. In either case it does not require a cash outlay, but only some labour which the villagers themselves might give free in seasons when they are not busy in their fields. The heaviest expense is likely to be fencing, but this is worth doing. The sowing and planting season is at the beginning of the monsoon, but the erection of fencing and the preparatory digging of planting holes could be done at any season when the zamindar could spare the time.

Third objection—the shade of trees injures crops. Hedgerow timber is a great feature of the English countryside. In many Punjab districts also a great deal of timber, firewood and fodder is produced from single trees growing on the field boundary or terrace walls. Admittedly, such trees do interfere to some extent with the crops below them. The sandier the soil and the less the rainfall, the greedier are the tree-roots in competing with the farm crop for soil moisture and nourishment. But the produce of the tree is just as necessary to the farmer as his wheat is, so that some ground may legitimately be given up to the growing of trees. Actually, if the trees were grown in a plantation and not scattered in the hedgerows, they would no longer compete with the field crops, and this objection would be forgotten.

There are also many odds and ends of waste ground round every village and along roadsides, pond-sides and mounds, where quite a lot of trees can be grown, but probably very little will be done in this way until there is some organisation in each village to provide for such things. The need for this type of village organisation is very great indeed.

Disforestation.

One of the chief causes of disforestation is the constant lopping of branches to make dry thorn hedges to protect the fields from animals. The amount of material used in this way is enormous because these hedges rot and have to be renewed each year.

A more sensible method of fencing is to use live hedge plants such as the *taur* or prickly pear, the common *phulai* thorn tree and the *agave* (known variously as century plant, Spanish bayonet, or aloe). In certain parts such as Hoshiarpur the *agave* is already much in use and forms a most satisfactory hedge, because it is easy to plant and needs very little attention for many years. This plant is the source of sisal hemp fibre, and research work in the Punjab University laboratory is being done under the direction of Professor Bhatnagar, who hopes to establish this fibre as a village industry. The Forest Department is trying to increase the stock of this plant in order to provide for distribution of plants to villagers who are prepared to use it for hedges.

Recent developments in the United States have focussed attention upon the part which forestry can play in the better management of farm lands. A great many trained foresters are now employed by that Government to help the farmers to grow their own plantations of trees. The policy there is to plan each farm community so as to make the best use of all land and this naturally includes the growing of trees in shelter belts, which will reduce the drying effect of wind on farm crops, and the planting of all ground which is too steep or too poor for crops or grazing. A privately owned farm plantation is there called a "wood-lot," and happy is the man who has one on his farm.

The forester has become a very necessary person in every American farming community and it is to be hoped that he will also find a place in the Punjab village, because afforestation of a part of the uncultivated land would solve many of the zamindar's present problems.—*The Civil & Military Gazette,* April 28th, 1937.

E

THE KARDHAI COPPICE-WITH-STANDARDS WORKING CIRCLE

(AREA—26,830 ACRES)

(Extract from the summary of the Working Plan ***for the Jhansi Forest Division****)*

This consists of the more or less pure *kardhai Anogeissus pendula* forests of the Mau, Jhansi and Talbahat ranges, and is sub-divided into eleven felling series.

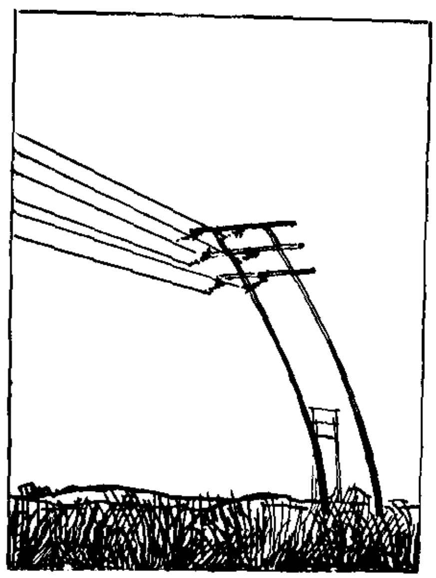
The silvicultural system is coppice-with-standards. The rotation is 30 years in all the felling series, estimated to give a crop just under 5″ diameter. The yield is regulated by area.

The method of felling is to coppice everything not more than 6″ above the ground. Thirty annual area coupes have been formed in each felling series and after the fellings subsidiary silvicultural operations may be carried out, at the discretion of the territorial staff. No artificial regeneration is prescribed, and the whole working circle will be fire-protected and kept closed to grazing for about 5 years after felling till the coppice shoots are safe. Early departmental burning is prescribed.

SANDSTORM SEVERELY TRIES STRENGTH OF H-FRAME WOOD STRUCTURES

About two years ago, the Southern California Edison Company constructed 22 miles of 66 kv. transmission line on H-frame wooden structures, on which 600 sets of Hubbard O-B double-plank arm fittings were used.

During a recent sandstorm, the mechanical strength of these structures was severely tried. From the accompanying photograph,



one can readily gain an impression of how strongly the wind must have blown. The cloudiness (*not reproduced*) of the picture is due to sand still in the air, for the storm then had not completely subsided. A latticed steel-pole structure, from which the wood-pole line took off, was completely wrecked and fell with its entire weight on the H-frame shown in the picture. One of the poles was slightly damaged. This, however, was readily repaired by the use of a thrubolt and pole band. The structure was restored to its normal state after the steel pole had been repaired.

The manner in which this wood-pole H-frame structure withstood this unusual loading is most gratifying to the engineers of the power company and is indicative of the strength against mechanical shock which is obtained in a correctly designed wood structure.—(*O-B Hi-tension News*, September 1933.)

EXTRACTS

AFFORESTATION FOR VILLAGES IN THE PUNJAB

BY R. MACLAGAN GORRIE.

Dr. R. Maclagan Gorrie, Indian Forest Service, in the course of the broadcast talk on "The Punjab's Fuel Supply," from the All-India Radio, Delhi, on Monday, said :

Many years ago an officer, named McConochie, who was Deputy Commissioner of Gurgaon, decided that as a punishment a certain offender should create a forest *rakh* by enclosing and protecting some of his own waste land. Twenty years later this same man sold the wood from this *rakh* as fuel and from the proceeds married off both his son and his daughter. It is a pity that all magistrates' sentences are not as productive of good as this one was.

What do we need fuel for ? Could we not get on quite well without it ? In the cold Punjab winter those who can afford it use a fire for warming the room, but even the poorest in the land need fuel all the year round for cooking. In addition to ordinary cooking, milk has to be kept hot all day and other dishes such as *dal* and *gowara* have to be kept simmering for long hours. In the towns charcoal from wood and Bengal mineral coal are being used and very large quantities of cow-dung are burnt, but for ordinary household cooking wood is always necessary. The wood supply is precious because there is so little of it and the easiest substitute is dried cow-dung. It is a common sight almost everywhere in India to see these dung cakes drying in the sun.

FARMYARD MANURE.

Many a time in the course of touring I have asked villagers why they burn cow-dung instead of using it for their fields and the reply is always the same : "Sahib, we know it ought to go to the fields, but we must have something to burn."

The bad effects of the burning of cattle manure are not fully realised. Farm crops cannot be grown without constant manuring and, if the fields are deprived of this source of plant-food, they will

deteriorate from year to year and produce crops poorer both in quantity and quality. The best manure of all, and the only one readily available to the Indian farmer, is farmyard manure. When this is used for burning, the fields are starved. The agriculture of India can never be put on a sound footing until this destructive and wasteful habit has been stopped and the manure is used to enrich the soil.

But the burning of cow-dung cannot be prevented unless the villagers have a cheap and plentiful supply of wood to burn. This surely is an excellent reason for starting village plantations, which will produce wood fuel and so save the cow-dung for its proper use as *the food of the soil. If the earth is deprived of her food, she will* no more do her work than men or cattle if deprived of their food, but there is a simple and effective cure, namely, the creation of village forest plantations.

Another source of fuel is the collection of straw, twigs and weeds. This burning of vegetable rubbish is another wasteful habit, because it would be put to far better use in the compost pit to increase the manure supply.

A real economy in the use of all fuel is the hay-box. This is a grand means of keeping milk and other food hot for many hours. The only fuel wanted there is to bring things to the boil before being popped into the hay-box.

Charcoal.

To turn to the charcoal supply, it is not every wood that makes a good charcoal. Of the hill forest trees, the pines and firs make poor charcoal and only the oaks are good. Of the plains species, shisham makes probably the best charcoal in the world and kikar and mulberry are also very good, so this explains why it is easier to get good charcoal in the plains than in the hills.

The charcoal supply for the larger hill stations is often brought very long distances by the charcoal burners themselves and sold so cheaply that it is difficult to see how those people can make a living.

In the canal colonies the early settlers had a supply of wood at hand in the slow-growing thorny *jand* and *phulai* trees of the scrub jungle, which had to be felled to make way for the new fields and farms. This supply gradually became exhausted as the virgin soil was brought under the plough. The present supply comes from the last relics of this thorn scrub, but it is not sufficient for the growing population, so that any roadside or canal-bank trees which are sold fetch a high price. In these canal colonies the Forest Department has made several plantations where trees are grown as an irrigated crop in just the same way as cotton or sugarcane, except that it takes several years to produce a crop of wood.

INTERESTING HISTORY.

These plantations have an interesting history. The first was started at Changa Manga in 1866 to grow firewood for the locomotives of the newly built railway to Multan and, after experimenting with many different trees, success was obtained with shisham. This found a good market both for timber and fuel.

Forty years ago, however, mulberry invaded the place and spread like a weed; the more it was cut down the better it grew. It was considered worthless until an enterprising Punjab Captain of Industry, Sirdar Ganda Singh Uberoi, thought of trying it for hockey sticks. It has now surpassed shisham in value and is the mainstay of the flourishing sports goods manufacture of Sialkot.

Most of the plantation output continues to be used as firewood and this forms the main supply for Lahore and Amritsar. This plantation yields a profit to Government of about Rs. 12 per acre per year and has already paid for itself several times over, which shows that even in competition with farm crops, wood is quite a paying proposition.

DAMAGE BY GRAZIERS.

Without the help of irrigation the growing of firewood is, of course, a slower business and in most of our foothill jungles the firewood is greatly reduced by the graziers, who ruthlessly hack and lop

trees to the very top in order to obtain food for their goats, sheep, camels and buffaloes. When a tree has been deprived of its leaves and reduced to a bare and mutilated trunk, one can hardly expect it either to put on any fresh growth of wood or to protect the soil in its vicinity.

Nature uses trees to keep the soil in the condition of a sponge, so that forest soil is capable of soaking up and storing a large proportion of the rain which falls upon it. However, if the plants on the ground are constantly grazed and the tree-tops are cut away, the forest can no longer function in storing water and increasing seepage to the deeper layers.

It should be realised that the production of timber and firewood cannot be satisfactorily combined with grazing ; in fact, uncontrolled grazing is the very worst and most uneconomic use to which any forest can be put. Proper protection against grazing is essential if any plantation is to succeed. This is not to say that the domestic animals will not profit from such closures; on the contrary, the supply of cut fodder, both of grass and the leaves of edible trees, is much better from a protected plantation than from the same ground under common grazing.

Chief Objections.

The chief objections to the planting of trees in village lands are : first, that no land is available for planting; second, that the villager cannot afford to plant trees ; third, that the shade of trees injures his crops.

To deal with each of these. First, the land for planting. There is no doubt that the zamindar has not enough plough land for his needs, but in most villages there is a large area of grazing common which is practically unproductive at present because it serves to keep alive a large herd of miserable thin cattle, useless because they give neither milk nor work, and merely rob the more thrifty cattle of their ration. If a third or even a tenth of each village grazing common was planted with trees, it would produce not only firewood and

timber, but also a better supply of cut fodder. What is required is not more land, but a more intelligent use of the land already there.

COST OF PLANTING.

Second objection—the cost of planting. The trees can be grown by sowing seed direct on the ground, or by growing small plants in a nursery until they are ready for transplanting. In either case it does not require a cash outlay, but only some labour which the villagers themselves might give free in seasons when they are not busy in their fields. The heaviest expense is likely to be fencing, but this is worth doing. The sowing and planting season is at the beginning of the monsoon, but the erection of fencing and the preparatory digging of planting holes could be done at any season when the zamindar could spare the time.

Third objection—the shade of trees injures crops. Hedgerow timber is a great feature of the English countryside. In many Punjab districts also a great deal of timber, firewood and fodder is produced from single trees growing on the field boundary or terrace walls. Admittedly, such trees do interfere to some extent with the crops below them. The sandier the soil and the less the rainfall, the greedier are the tree-roots in competing with the farm crop for soil moisture and nourishment. But the produce of the tree is just as necessary to the farmer as his wheat is, so that some ground may legitimately be given up to the growing of trees. Actually, if the trees were grown in a plantation and not scattered in the hedgerows, they would no longer compete with the field crops, and this objection would be forgotten.

There are also many odds and ends of waste ground round every village and along roadsides, pond-sides and mounds, where quite a lot of trees can be grown, but probably very little will be done in this way until there is some organisation in each village to provide for such things. The need for this type of village organisation is very great indeed.

DISFORESTATION.

One of the chief causes of disforestation is the constant lopping of branches to make dry thorn hedges to protect the fields from animals. The amount of material used in this way is enormous because these hedges rot and have to be renewed each year.

A more sensible method of fencing is to use live hedge plants such as the *taur* or prickly pear, the common *phulai* thorn tree and the *agave* (known variously as century plant, Spanish bayonet, or aloe). In certain parts such as Hoshiarpur the *agave* is already much in use and forms a most satisfactory hedge, because it is easy to plant and needs very little attention for many years. This plant is the source of sisal hemp fibre, and research work in the Punjab University laboratory is being done under the direction of Professor Bhatnagar, who hopes to establish this fibre as a village industry. The Forest Department is trying to increase the stock of this plant in order to provide for distribution of plants to villagers who are prepared to use it for hedges.

Recent developments in the United States have focussed attention upon the part which forestry can play in the better management of farm lands. A great many trained foresters are now employed by that Government to help the farmers to grow their own plantations of trees. The policy there is to plan each farm community so as to make the best use of all land and this naturally includes the growing of trees in shelter belts, which will reduce the drying effect of wind on farm crops, and the planting of all ground which is too steep or too poor for crops or grazing. A privately owned farm plantation is there called a "wood-lot," and happy is the man who has one on his farm.

The forester has become a very necessary person in every American farming community and it is to be hoped that he will also find a place in the Punjab village, because afforestation of a part of the uncultivated land would solve many of the zamindar's present problems.—*The Civil & Military Gazette*, April 28th, 1937.

THE KARDHAI COPPICE-WITH-STANDARDS WORKING CIRCLE

(AREA—26,830 ACRES)

(Extract from the summary of the Working Plan for the Jhansi Forest Division)

This consists of the more or less pure *kardhai Anogeissus pendula* forests of the Mau, Jhansi and Talbahat ranges, and is sub-divided into eleven felling series.

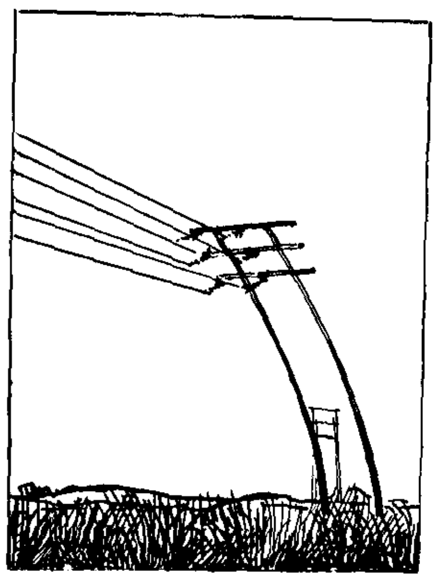
The silvicultural system is coppice-with-standards. The rotation is 30 years in all the felling series, estimated to give a crop just under 5″ diameter. The yield is regulated by area.

The method of felling is to coppice everything not more than 6″ above the ground. Thirty annual area coupes have been formed in each felling series and after the fellings subsidiary silvicultural operations may be carried out, at the discretion of the territorial staff. No artificial regeneration is prescribed, and the whole working circle will be fire-protected and kept closed to grazing for about 5 years after felling till the coppice shoots are safe. Early departmental burning is prescribed.

SANDSTORM SEVERELY TRIES STRENGTH OF H-FRAME WOOD STRUCTURES

About two years ago, the Southern California Edison Company constructed 22 miles of 66 kv. transmission line on H-frame wooden structures, on which 600 sets of Hubbard O-B double-plank arm fittings were used.

During a recent sandstorm, the mechanical strength of these structures was severely tried. From the accompanying photograph,



one can readily gain an impression of how strongly the wind must have blown. The cloudiness (*not reproduced*) of the picture is due to sand still in the air, for the storm then had not completely subsided. A latticed steel-pole structure, from which the wood-pole line took off, was completely wrecked and fell with its entire weight on the H-frame shown in the picture. One of the poles was slightly damaged. This, however, was readily repaired by the use of a thrubolt and pole band. The structure was restored to its normal state after the steel pole had been repaired.

The manner in which this wood-pole H-frame structure withstood this unusual loading is most gratifying to the engineers of the power company and is indicative of the strength against mechanical shock which is obtained in a correctly designed wood structure.—(*O-B Hi-tension News*, September 1933.)

NATURAL RESINS AND SHELLAC

Lecture delivered by Mr. A. J. Gibson, Special Officer, Lac Enquiry, at a Symposium held at the Institution of Mechanical Engineers, January 29th, 1937.

The natural resins, both by reason of the extent of their uses and the long period during which the world has been making use of them, are deserving of considerable attention in any survey of raw or semi-manufactured materials available to-day in the paint varnish and plastics industries. I last reviewed the whole field in a lecture

in 1933[1] and details, inexorably barred by the time-limit imposed on the present paper, will be found in the paper cited.

The principal natural resins and their approximate annual production can be gauged from the fact that in 1935 the tonnage was 687,000 in round figures (see Table I).[2] The annual fluctuations are considerable and the above total may vary from anything between 650,000 and 750,000 tons in any given year. The bulk of these resins are the recent or fossil vegetable exudations of coniferous trees; lac is an important exception.

The above tonnage is very large in comparison with the estimated world-production of 160,000 tons per annum of synthetic resins. That figure comprises all the phenolic and urea resins, the glyptal, vinyl and coumarone resins, etc., and also cellulose nitrate and acetate (see Table II).[3] The figures are of necessity approximate, as producers of synthetic resins are generally averse to disclosing statistics of output.

The United Kingdom is almost entirely dependent on countries outside the British Empire for its supplies of natural resins, imports being close on 100,000 tons a year, valued at, at least, £2 million (see Table III).[4]

As regards copal and other resins the British Empire production can be gauged from an " Index of the Minor Forest Products of the British Empire" recently issued by the Imperial Economic Committee[5] and from Mr. T. Hedley Barry's authoritative book on the natural resins.[6]

Briefly, as regards rosin, the United States of America is the largest exporter to the United Kingdom, followed, but very far behind, by Portugal, other European countries and Spain.[4]

British India is the only country in the British Empire producing rosin; its exports to the United Kingdom in 1934 were 300 tons[4]; its estimated annual productive capacity is 20,000 tons[5]; its present production 5,000. British Honduras and the large and extending but young pine plantations in Western Australia, Southern Australia and New Zealand are possible future sources of supply.

As regards copal, production within the Empire is negligible.[5] Dammar from Malaya and Kauri resin from New Zealand are available in fair quantity[5] but the total production is not very large and the uses restricted, mainly as varnishes, in linoleum and in combination with nitrocellulose lacquers.

Lac, and its products such as shellac, garnet and button lacs, is practically a British India monopoly, with Calcutta the clearing house for exports.

The United Kingdom takes normally about 25 per cent. of the annual output, the United States of America about 40 per cent., Germany about 15 per cent. and Russia, Japan, France and the rest of the world, the balance. An abortive attempt to corner the shellac market in London in 1934 led to a huge accumulation of standard TN shellac, to-day standing at well over 7,500 tons, about four to five times the normal. The position is improving largely by the development of a policy of re-exports, which in 1936 amounted to over 4,000 tons, principally to Russia.

Turning now to the uses for natural resins. The principal outlet for rosin[7] is in the paper sizing industry, 35 per cent. of the annual output; soap comes next with 25 per cent; varnishes and printing inks account for another 25 per cent., while a mass of industries, of which perhaps the most interesting are metallic resinates and a rosin-synthetic resin compound, absorb the remaining 15 per cent. Rosin is also used for binding the shrapnel in shrapnel shell, the rosin being poured in hot and allowed to cool.

Research on a very large scale organised by the large "naval stores" corporations in the United States of America, and on a smaller scale by the French resin industry is finding new uses for rosin at a considerable rate. After a series of lean years, prices are going up and the industry to-day is in a sound position, largely due to the fact that the products have been graded and sold against standards for nearly half a century.

The copals[6] find their principal uses in oil-varnishes and protective coatings. The second paper in this group will probably give more information on this point, so no further reference is required here.

Lac products, including shellac, as true thermoplastic materials with some unique properties, have until recently found their principal outlet[5] in gramophone records, while protective and insulating coatings, both in alcoholic and alkali solutions, constitute the second largest group of uses. It is in this group that uses such as varnishing of the inside of shells, water tanks and tank steamers find a place. Micanite and micafolium deserve special mention, the binder being shellac. The other resins mentioned (in Table I)[3] are used principally in varnishes and protective coatings and require no detailed account of their uses,[6] apart from what has already been stated in this paper.

Standardization and research, either on the initiative of or by the Governments concerned, by statutory committees or organisations set up for the purpose,[8] have and will do much to improve the raw materials I have described and ensure their best utilization in modern industrial practice.

To summarise : it will be seen from this brief account that the natural resins used in the United Kingdom are all imported and that apart from lac and very small quantities of rosin and some other resins the United Kingdom is largely dependent on foreign sources of supply. The normal stocks held in this country are small. Expansion in production in the producing countries at any given moment will take time, more especially where fresh tapping is involved as in the case of rosin, dammar and kauri. It has, however, been demonstrated that lac exports can easily go up 20 per cent. in any one year, due to large quantities of the crude lac, *viz.*, sticklac, being carried forward customarily from year to year, a phenomenon which not only astounded but confounded the London speculators who attempted a shellac corner in 1933-34.

The remedy or remedies applicable to this state of affairs, which proved serious in the last national emergency, can only be suggested. The holding of adequate stocks in the United Kingdom is a simple solution, but involves the tying up of a great deal of money. A conference between the authorities concerned in India, the colonies and the Commonwealths of Australia and New Zealand would ensure

the best possible utilisation of the existing Empire sources of natural resins and their expansion. The Imperial Economic Committee is clearly indicated as the body to organise such a conference.

A. J. GIBSON,
Special Officer, Lac Inquiry.
London Shellac Research Bureau,
India House, Aldwych.

London, W. C. 2.
22nd January 1937.

References.

(1) A. J. Gibson : " Journal of the Society of Chemical Industry, " 1933, 52 (May 19), p. 88.

(2) *Table I*—

	Annual production Tons. (Figures rounded off).
Rosin or Colophony	600,000
Manila and other Copals (of which Congo Copal 20,000) ..	36,000
Lac and Shellac	32,000
Dammars	11,000
Kauri Resin or Copal	4,000
Accroides Resin	1,000
Other Resins	3,000
Total ..	687,000

TABLE II. (3)

Phenolic and other Synthetic Resins.	Tons. p. a.	Cellulose Acetate and Nitrate, etc.	Tons. p. a.
U. S. A. ..	50,000	U. S. A. ..	15,000
Germany ..	22,000	Rest of World ..	25,000
France ..	9,000		
United Kingdom ..	16,000		
Rest of World ..	23,000		
	120,000		40,000

Grand Total 160,000 Tons (figures rounded off).

(3) See Annual Report, London Shellac Research Bureau, *1935-36, pp. 9* and *10.*
Also: "*Plastische Massen,*" Sept. 1936, Vol. 6, No. 9, p. 309.

TABLE III (4).

Imports of Natural Resins into the United Kingdom (in tons—figures rounded off).

	1934.	1935.	1936.
Rosin	69,000	72,000	71,000
Copal	7,600	10,500	10,800
Lac and Shellac	22,000	4,600	6,700
Other Resins (including Dammar and Kauri Resins)	4,000	7,200	7,700
Totals ..	92,600	94,300	96,200

(4) See Board of Trade Monthly Returns, Dec. 1936, p. 55.

(5) "Index of the Minor Forest Products of the British Empire," Imperial Economic Committee, 1936, pp. 44-54. Publishers—His Majesty's Stationery Office, 5*s*.

(6) "Natural Varnish Resins," by T. Hedley Barry, 1932. Publishers—Ernest Benn, Ltd., £2-2*s*.

(7) "Industrial and Engineering Chemistry" (News Edition), 12, No. 3, Feb. 10, 1934, p. 40.

(8) *i*. "An Act to make Provision for the Control of the Trade and the Export of Kauri Gum," No. 34, 1925, New Zealand.

ii. Forest Department, Malay States and Straits Settlements, Regulations for Grading Dammars.

iii. Netherlands East Indies, Regulations for Dammar and Copal.

iv. Indian Lac Cess Act (No. XI of 1936) Controlling Research on Lac at the Indian Lac Research Institute, Ranchi, India, the London Shellac Research Bureau, United Kingdom and the associated New York Shellac Research Bureau.

v. Belgian Congo Ordinance of October 1936 for Grading Copal.

vi. (*a*) The London Shellac Trade Association, London.

(*b*) The United States Shellac Importers' Association and the American Bleached Shellac Manufacturers Association, New York.

(*c*) The American Gum Importers' Association, New York.

BRITAIN RETURNS TO HER WOODEN WALLS

By Vice-Admiral C. V. Usborne, C.B., C.M.G.

Once again warships are being built for the British Navy—of wood!

It is true they are not large warships, being a mere 60 feet long and having a displacement of only 17 tons, but they are the first of a new type. They put into effect what is, for the British Navy, an entirely new conception, and for this reason they are important.

In these doubtful days, when the aeroplane and the submarine shake their fists in the face of the battleship and almost, but not quite, succeed in driving that marine monster off the seas, any new type of war vessel has significance and unknown potentiality.

Light and Fast.

These latest British "warships" have been designed by Mr. Scott-Payne of the British Power Boat Company at Hythe, Southampton Water, and fulfil an Admiralty requirement for a small, specially fast torpedo boat which can keep the sea. They are not stepped, but have an underwater form, sharp forward and flat-bottomed aft, which lifts them out of the water as they move forward

at speed. They are very shallow draft, and the speed of the first models when loaded is 36 knots. Doubtless much greater speeds will be attained in later models.

ADVANTAGES OF WOOD.

But, one asks, what are these back-to-the-ark craft for? And why in the name of Davy Jones should they be built of wood? Surely we have long ago proved metal superior to wood. I will answer the last question first. For a light craft, to be driven at high speed, a metal hull is tinny, easily damaged and most unpleasant to live inside. Wood permits of a much thicker side, gives resilience, lightness, warmth, and is easy to repair. The boats take a lot of sinking, for besides being divided into several watertight compartments, a patch can be put on anywhere.

(Illustrated Weekly of India, 14th March 1937.)

DRY-ROT INVESTIGATIONS—GENERAL REMARKS.

(Extract from "Dry-Rot Investigations in an Experimental House," Forest Products Research Records No. 14, Mycology Series No. 1, Department of Scientific and Industrial Research.)

SOLID FLOORS.

The results of the first series of experiments have been conclusive and will be of use in drawing up specifications for this type of floor.

BAD CONSTRUCTION.

The fact that errors in construction may lead to an immediate outbreak of dry-rot has been clearly demonstrated, but, owing to abnormally dry weather conditions, the attack has not yet progressed sufficiently far for experiments upon curative measures to be carried out.

GOOD CONSTRUCTION.

It has been shown that if a floor has been well constructed with proper provision for ventilation so that the moisture content of the

timber is kept below 20 per cent., dry-rot fungi will not develop, even if active infection of the most virulent type be introduced.

Dry-rot can attack fairly dry timber only if the fungus is spreading from an already infected damp area from which it is able, by means of its strands, to draw a supply of moisture, but if the ventilation is sufficiently good, then it can make only slight progress.

It is thus evident that it is more important that the construction of the building should be well designed than that the timber should be absolutely free of infection. It is, of course, highly desirable that the timber should be as far as possible free from infection, in case any subsequent leakage or accumulation of moisture should occur which might favour its development. It is, however, absolutely essential that in designing a building, the precaution should be taken of ensuring that no moisture reaches any timber that is not thoroughly treated with preservative, since fungal infection is certain sooner or later to appear on any timber remaining in a condition suitable for its development.

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for July, 1937:

IMPORTS

ARTICLES	MONTH OF JULY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	110	1	..	15,692	130
French Indo-China ..	..	57	..	..	7,232	..
Burma ..	..	..	12,334	..	..	15,16,709
Other countries ..	..	..	5,705	22	..	91,240
Total ..	..	167	18,040	22	22,924	16,08,079
Other than Teak—						
Softwoods ..	868	1,051	2,125	59,139	59,595	1,73,446
Matchwoods ..	..	656	1,072	..	35,468	57,316
Unspecified (value) ..	..	..	..	1,11,286	20,018	1,82,034
Firewood ..	142	14	41	2,138	210	615
Sandalwood ..	23	10	30	6,762	5,265	11,449
Total value of Wood and Timber ..	..	..	..	1,79,325	1,20,556	4,24,860
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Plywood ..	..	279	552	..	63,485	1,01,911
Other manufactures of wood (value) ..	..	..	..	2,17,539	1,47,647	1,61,135
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,17,539	2,11,132	2,63,046
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	38,449	9,632	33,059	2,58,632	70,741	2,76,466

EXPORTS

ARTICLES	MONTH OF JULY					
	Quantity (Cubic Tons)			Value (Rupees)		
	1935	1936	1937	1935	1936	1937
Wood and Timber						
Teakwood—						
To United Kingdom ..	3,835	2,332	40	7,51,453	4,93,664	6,156
" Germany ..	327	327	..	71,970	76 967	..
" Iraq ..	261	76	14	42,850	18,548	3,145
" Ceylon ..	35	28	..	5,164	3,807	..
" Union of South Africa ..	351	222	..	60,386	40,507	..
" Portuguese East Africa ..	110	112	..	19,502	20,084	..
" United States of America ..	68	52	..	16,858	15,641	..
" Other countries ..	627	401	67	1,27,868	73,316	18,947
Total ..	5,614	3,550	121	10,96,051	7,42,534	28,248
Teak keys (tons) ..	494	129	..	72,450	17,700	..
Hardwoods other than teak ..	22	144	..	2,137	14,440	..
Unspecified (value) ..	..	..	..	13,242	43,490	76,389
Total ..	..	..	..	87,829	75,630	76,389
Sandalwood—						
To United Kingdom ..	..	..	..	..	..	..
" Japan ..	5	5	5	5,920	5,500	6,000
" United States of America ..	61	..	..	62,810	..	..
" Other countries ..	9	20	47	9,365	24,975	45,437
Total ..	75	25	52	78,095	30,475	51,437
Total value of Wood and Timber ..	..	..	..	12,61,975	8,48,639	1,56,074
Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	9,018	13,825	26,112
Other Products of Wood and Timber ..	No data			No data		

INDIAN FORESTER

NOVEMBER, 1937.

A NOTE ON ULMUS VILLOSA BRANDIS AND ON OTHER *ELMS IN THE N. W.* HIMALAYA

BY R. N. PARKER, I.F.S.

Abstract.—The present position of *Ulmus villosa* Brandis as a wild and cultivated tree is indicated from which it is inferred that its former occurrence as a wild plant was more extensive than at present. The probable disappearance of *U. wallichiana* from many areas where it is now found is also predicted. It is suggested that *U. pumila* now only known as a tree rare in cultivation may be indigenous.

Ulmus villosa for which *U. laevigata* Royle is an older name (but though Royle has left specimens in his herbarium he omitted to supply an adequate description) is undoubtedly the finest elm found in the west Himalaya. It has always been somewhat of a puzzle to me as to where this tree is indigenous. It is usually found either as a planted tree or on the edges of fields, in the latter case invariably heavily lopped for fodder. These lopped specimens are not at all common and as *U. villosa* is said not to ripen its seeds their origin is not easily explained. I once examined fruits of this elm and came across one that appeared to contain a fertile seed but examination of a great number of fruits collected both off the tree and from the ground below failed to show another fully developed seed.

It is fairly common in Kulu as a road-side tree but always large and probably about 60 to 80 years old. Small specimens in Kulu are, as far as I have seen, very scarce. In Mandi State there are a number of specimens planted on the road-side and apparently 5 to 20 years old. They are said to be grown from seed. Attempts have been made by the Silvicultural Research Division to grow this elm both by cuttings and from seed. The first year produced only two plants, one from a cutting and one from seed. It is therefore evident that this elm does produce fertile seed but apparently only a very small proportion is fertile.

It is undoubtedly indigenous along the Pabar river in Bashahr and along the Andri khad, a big tributary of the Pabar, at 6,000 to

6,500 feet. It is found growing with *Alnus nitida* on islands and on the bank of the streams. It also occurs on flat ground at the bottom of the valley and ascends a short distance up the hill-sides. Every specimen is very heavily lopped for fodder, even the small ones, and it is evident that under present conditions it will not exist long in this area.

It is possible to picture what has occurred in Kulu. As a road-side tree in Kulu *U. villosa* is mixed with alder and evidently 60 to 80 years ago it occurred along the Beas growing as it still does on the Pabar. Natural seedlings were formerly available for use on the road-side. Lopping has practically exterminated all the old natural specimens and grazing effectually prevented any reproduction. The same thing has doubtless occurred in the Sutlej valley, Chamba and Hazara where this elm now gives the impression of not being indigenous. Another tree *Ligustrum compactum* has, to my knowledge, been almost exterminated in the Pabar valley within less than 30 years by grazing and lopping. According to my notes made in 1908 this tree was not uncommon in the forests of the Pabar valley though heavily lopped for fodder. It occurred gregariously in thickets of poles and saplings on islands and on the banks of the Pabar river. In a recent tour of over a month in the Pabar valley including following the river for over 20 miles, I only noticed a single specimen growing at the foot of a vertical bank of the river where it was effectively protected. Under present conditions in most parts of the N. W. Himalaya no tree of special fodder value is likely to survive long unless it is cultivated on private land.

Ulmus wallichiana Planch. This elm is likely to survive much longer than *U. villosa* because it grows at higher elevations and is, therefore, less accessible. It too is very much lopped for fodder and small specimens, which are scarce, are allowed little chance of growing as they are almost always lopped. Unlopped examples are only met with in unfrequented places. Large specimens often escape as the tree has a very straight bole with few low branches and are consequently difficult to climb. The Silvicultural Research Division found no difficulty in growing it from seed.

Ulmus pumila Linn. This species is not at all well known in the Himalaya. It occurs from Simla to the Nepal border but is not common. I have only seen one specimen in the Simla district and a few in Almora, all on the edge of cultivation and apparently planted for fodder. It may be an introduction from China or Central Asia but in view of what I have written under *U. villosa* it may have been indigenous and now only survives as an occasional cultivated specimen.

GRAZING AND ITS EFFECT ON SIMUL REGENERATION

BY J. B. ROWNTREE, I.F.S.

Summary.—Advance growth is found to be scarce in areas grazed throughout the year or not grazed at all and prolific in areas grazed only during the cold weather. Breaking up of the soil by cattle probably assists regeneration and fire protection brought about by grazing and the closing of the area to grazing during the growing season assists establishment.

In a recent number of this journal I read an article by Mr. Kaith on the effect of grazing on sal regeneration. The following notes on grazing and its effect on *simul* regeneration will, it is hoped, be of interest to readers of this journal.

The views recorded in this article are all based on observations made in the Laokhowa reserve of the Nowgong division of Assam. This reserve is situated on the south bank of the Brahmaputra river at about latitude 26° and longitude 93°. It consists of savannah type forest of *simul* (*Bombax malabaricum*) with some *koroi* (*Albizzia procera*) standing over such grasses as *ekra* (*Erianthus ravennae* and *khagori* (*Saccharum spontaneum*) and *sun* (*Imperata cylindrica* var. *koenigii*). The soil is Brahmaputra alluvium consisting of sandy silt and the configuration of the ground is generally flat interspersed with narrow ridges of higher ground.

It is on these ridges that the tree growth is to be found. The intervening low-lying area is unproductive and only contains grass.

The maximum and minimum shade temperatures for the area are about 100° and 50° respectively.

Annual fires run through the area during the hot weather and during the rains most of the low-lying land between the ridges goes

under water for varying lengths of time on account of the Brahmaputra floods.

The writer recently toured throughout the reserve with a view to deciding on the degree of grazing which might be allowed in the area without having a harmful effect on the forest from a silvicultural point of view.

It should be noted here that as far as grazing is concerned three types of forest exist in the reserve. In the first no grazing is allowed at all as this part is kept as a sanctuary for wild animals. In the second grazing by village cattle is allowed all the year round and in the third grazing by buffaloes of professional graziers is allowed during the cold weather only, *i.e.*, from November to April.

In the area where no grazing takes place very little advance growth was noticed. Only an occasional seedling has been able to establish itself here and there. Such an area is shown in figure 1, **Plate 51**. Here the grass is so thick that the annual fires are very fierce, and probably for this reason seedlings are unable to establish themselves. In the second type where grazing is allowed throughout the year grazing is excessive and the grass is closely cropped and becomes thick and matted consisting of such species as *Cynodon dactylon*, *Imperata cylindrica*, var. *koenigii* (depaunperate farm) and *Chrysopogon aciculatus*. Such an area is shown in figure 2. It will be noticed that natural regeneration occurred some years ago when grazing was presumably less intense, but that nowadays no fresh advance growth is to be seen.

The third type of forest where grazing occurs only during the cold weather is the only one in which advance growth is to be found to any extent. Here also where grazing has been excessive the same conditions as those shown in figure 2 are to be found and where grazing has been very slight conditions similar to those portrayed in figure 1 exist. Where, however, grazing has been just sufficient to thin out the grass so that the annual fires are effectively reduced in intensity, in such places a large number of young seedlings are to be found. Such an area is depicted in figure 3 where young seedlings one to two years of age are seen establishing themselves. Figure 4,

Fig. 1.

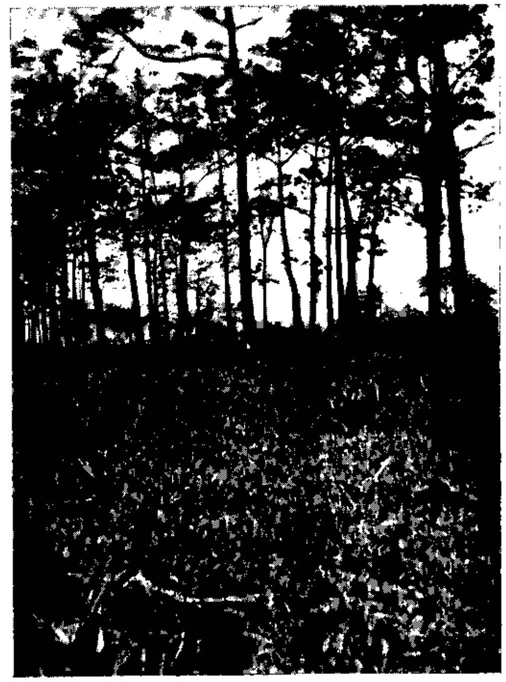


Fig. 2.

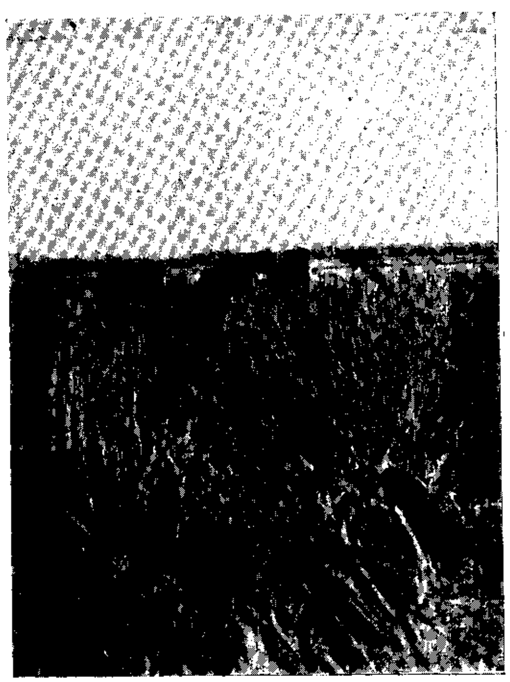


Fig. 3.

GRAZING AND ITS EFFECT ON SIMUL REGENERATION.

Photos : J. B. Rowntree.

Fig. 4.

Fig. 5.

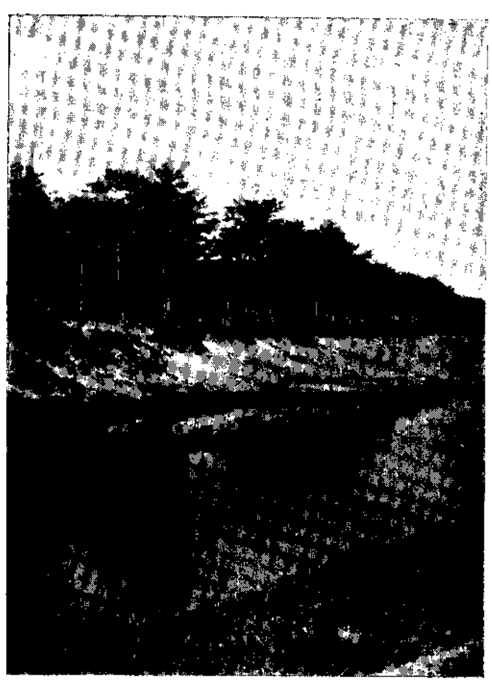


Fig. 6.

GRAZING AND ITS EFFECT ON SIMUL REGENERATION.

Photos: J. B. Rowntree.

Plate 52, shows a similar area where the seedlings are three to four years old ; and figures 5 and 6 show such areas fully stocked with 10 or 11 years old *simul*. In figure 5 one of the original seed trees can be seen in the centre of the picture. It is of interest to note that this advance growth occurs in even age blocks and that few, if any, *simul* seedlings of a later date are found on the ground in such blocks. This is not necessarily due to the canopy being too dense because elsewhere it was noticed that other conditions being favourable natural regeneration occurred under shade of equal density. It is more likely due to the fact that after the establishment of the older seedlings grazing became too intense to allow of any further regeneration taking place.

Although the views expressed above were borne out by the facts noted in different parts of the reserve, it must be admitted that in many places where the intensity of grazing appeared to be just right for natural regeneration to take place, none was to be found. This, however, was probably due to other factors such as damage to the growing stock by floods.

It is also of interest to note that most of the advance growth occurs along the bank of the Brahmaputra. This might be accounted for by the fact that successive floods had deposited their silt along the bank, and that it is only within recent years that the level of the ground has become sufficiently high for natural regeneration to take place to any extent.

In the opinion of the writer, however, the fact that the buffalo *khuties* are situated along the river bank and that this area is the most heavily grazed, has much more to do with it. This is borne out by the fact that grazing has only been allowed in these parts of the reserve for about the last 15 years and the oldest blocks of advance growth appear to be 10 or 11 years old.

The fact that silt is deposited near the river by exceptionally high floods and that this silt does not become solidified to the same extent as the soil in the interior of the reserve, and that the soil surface is broken up by the hooves of the buffaloes, may also assist the germination of *simul* seed. Such conditions are very similar to those found

in freshly abandoned *jhum* land where the soil has recently been broken up and where natural regeneration of *simul* is usually found to be profuse.

In conclusion it seems obvious that grazing is responsible for the very fine regeneration of *simul* to be found in parts of the reserve, although this is probably effected also by other factors. The chief effect of grazing would seem to be the thinning out of the grass and the consequent reduction in the fierceness of the annual fires, which allows the young seedlings to get away, provided that such grazing is restricted to the cold weather, and does not take place during the growing season. Fire protection, even if possible, would probably not bring about this state of affairs, because the grass would become so thick and matted that seed would be unlikely to reach the ground, but actually such fire protection would be impossible in this case, because although the area could be protected from without, it would not be possible to prevent fires from starting inside the reserve on account of the large number of people who for one reason or another have to be allowed access to the area.

Grazing would therefore seem to be the only solution to the problem and it remains to find out, by experiment, the degree of grazing most suitable for the purpose.

THE FORESTS OF UPPER ASSAM

By J. N. Sen Gupta, Experimental Assistant Silviculturist, F.R.I.

Abstract.—A summary of the writer's tour notes on plantations and other silvicultural experiments on the problem of natural and artificial regeneration in certain important centres of the evergreen forests of Upper Assam (visited during January 1937),—with proposals for the future, *vis-à-vis* different local sub-types.

1. *Introduction.*—In a really thought-provoking article under the cryptic title of SCRAP THE LOT, published in the *Indian Forester* of October 1932, the late Mr. Martin raised, in his inimitable style, considerable interest in the regeneration problem of the Upper Assam evergreen forests and focussed everyone's attention towards the way

the wind was blowing. The policy adumbrated in that article summarised the general trend of views in the province and has, in fact, held the ground during the last decade in some form or other, in the silvicultural and working plan technique for the upper reserves of the Brahmaputra valley.

2. Beyond claiming " but distant kinship " (with perhaps a greater degree of boldness than the local forest officers), the writer does not pretend to belong to that order of " distinguished cousins or super-distinguished uncles of the Forest Metropolis," whose visits were lamented as so rare and whose words of wisdom as so few. It was primarily to obtain first-hand information (may be for a little self-introspection) regarding the silvicultural progress during the last decade, since Mr. H. G. Champion visited Upper Assam early in 1926, that the writer was privileged to undertake a month's tour in January 1937. The following pages are but a summary of his observations on some of the important centres of silvicultural work in the forest divisions of the Surma and Brahmaputra valleys that fringe the Naga and Manipur hills, forming together the North-East Frontier of the present-day India. The limitation of a " bird's -eye view " is admitted at the very outset.

3. *General description of localities.*—With an itinerary that started from Srimangal (SYLHET division) and continued through Silchar (CACHAR), Jaipur, Makum, Dibrugarh (LAKHIMPUR), Sibsagar, Jorhat, Dimapur (SIBSAGAR division) and Diphu (NOWGONG), the plains and lower hill reserves of the Surma valley and those on the south bank of the Brahmaputra were adequately traversed.

4. While (*i*) the upper reaches of CACHAR are irregular and comparatively hilly with rocky precipices in places, the general configuration of the tracts visited is (*ii*) almost flat to gently sloping in the alluvial plains of the Brahmaputra valley (Barrajan, Podumoni, Jokai, Dehingmukh, Sola, Hollangapara and Bokajan reserves), (*iii*) somewhat undulating or broken by groups of *tilas* (low isolated hills) between flat and swampy tongues of cultivation in the old alluvium Surma valley (Srimangal, lower CACHAR), and (*iv*) the rest, bordering the Naga hills and structurally a part of them, a series of

low spurs and broken foothills of varying altitudes between 350′ and 1,600′.

5. The high hills in (*i*) are formed of upper tertiary sand-stones with resultant sandy soil; the plains in (*ii*) are mostly of Dehing alluvium origin with loam of considerable depth and fertility—in places rich in coarse sand while with a greater proportion of clay and silt in areas close to the older beds of the Brahmaputra (*e.g.*, Jokai, Dehingmukh and Sola); the *tilas* in (*iii*) are of old alluvial red sand with occasional bands of clay and gravel, often indurated with ferruginous cement; and lastly the foothills in (*iv*) are of tertiary sand-stones and shales with the soil, a good quality sandy loam of recent alluvial formation. The general slope and tributaries of the two large rivers ensure good natural drainage, although adverse soil conditions (clayey or rocky sub-stratum), earth-cuttings, high roads and railway embankments have locally caused the formation of some swamps of varying extent.

6. *Climate.*—There are no great extremes of temperature, and these valleys are characterised by constant high humidity (average relative 85 to 90), and heavy and frequent rainfall. The Surma valley being almost due north from the apex of the Bay of Bengal and, therefore, directly exposed to the south-west monsoon, receives the greater and earlier amount of the annual rainfall (about 150″ at Srimangal and 120″ at Silchar) than the Brahmaputra valley (about 115″ near the Naga foothills, with local variations between 75″ and 95″ in the plains). November to February are the four comparatively dry months with less than 2″ monthly rainfall, the maximum precipitation is during May to September. A fair amount of well-distributed rainfall occurs during the month of April, which is quite propitious for early regeneration work. The average mean annual temperature is 76° between the mean maximum of 90° (June to August) and mean minimum of 50° (January), while along the eastern hill ranges 95° and 40° respectively, with heavy dews at night and dense morning mists; frosts are extremely rare.

7. *Types of forests.*—Although the general type is tropical evergreen with a bewildering number of species presenting a

LOCALLY GREGARIOUS *Dipterocarpus turbinatus* WITH *dolu* BAMBOOS (*Teinostachyum dulloon*) UNDERNEATH, AND ABUNDANT NATURAL REGENERATION ALONG THE SLOPES OF *tilas* (LOW HILLS) BETWEEN TONGUES OF CULTIVATION [PHULERTHOL, CACHAR, *vide paras.* 4 5 *and* 22].

A *hollong* (*Dipterocarpus macrocarpus*)—*nakor* (MESUA FERREA) TYPE OF EVERGREEN FOREST IN SIBSAGAR—DISOI EXPERIMENTAL PLOT. THE PROMINENT *hollong* TREE IS OVER 17 FT. IN GIRTH AT B. H. AND OVER 100 FT. IN HEIGHT [*vide para.* 10].

Photos: J. N. Sen Gupta.

somewhat three-storeyed appearance, there are several local sub-types, according as their ecological status is climax, successional or retrogressional, distinct or overlapping, as mentioned below:

I. The lower areas and isolated *tilas* of SYLHET and CACHAR represent a *sub-climax* stage of potential tropical evergreen forest, since cleared and largely altered by biotic influences. Forest areas had been heavily *jhumed* (under shifting cultivation) prior to reservation, with the result that the existing high forest is now composed of a secondary growth of deciduous and semi-evergreen species occurring sporadically over an undercrop of prolific bamboos (specially *Melocanna*) and *Eupatorium odoratum*, etc.

II. The higher and remoter areas having been less altered by biotic factors contain more evergreen forests which are mostly confined to steep uncultivable slopes, rocky and shady stream banks, and represent a transitional *intermediate* stage between the sub-climax mixed evergreen (as in I) and the *climax* evergreen (as in III below) of Upper Assam with the highest stage of development in the unexploited high forest on the frontier hills.

III. This latter type is best represented in the truly evergreen forests of Jaipur and Digboi of LAKHIMPUR and to a less extent in Disoi of SIBSAGAR.

IV. The plains reserves in the Brahmaputra valley (south bank) with a heterogeneous mixture of the deciduous and the evergreens in varying proportions of their occurrence according to proximity to the borders of the Naga hills represent what may be differently termed as *mixed or sub or semi-evergreen* type. This is illustrated in that the forests of Barrajan, Hollangapara, Sola and Podumoni are more evergreen than those of Dehingmukh and Jokai, while Bokajan and Diphu are less so.

8. The heavily *jhumed* forests of sub-type I have been left long enough to be restocked with a secondary growth of mixed species such as *Vitex, Lagerstroemia parviflora, Schima wallichii, Nauclea sessilifolia, Dillenia pentagyna, Macaranga* and *Callicarpa*, etc. (*e.g.* Lowachera at Srimangal). In the high forests, not so heavily *jhumed*, *Dipterocarpus turbinatus* (*gurjan*) and *Artocarpus chaplasha* (*sam*)

are the more prominent valuable trees that occur somewhat sporadically—the former tending to be locally gregarious—without attaining very great heights above a lower storey of evergreens like *Eugenia*, *Quercus* spp., *dolu* bamboo (*Teinostachyum dullooa*) and canes, etc. There are localised patches of natural seedlings of *gurjan* under and around mother trees, healthy or stagnant in growth according as they are exposed to light or not. Natural regeneration of *sam* is largely browsed by game.

9. The next higher stage under sub-type II is characterised by fewer giant trees but more numerous bamboos in the underwood than the climax evergreen sub-type III. The seemingly distinct tiers in the upper storey consist of sporadic (or locally gregarious) *gurjan*, *sam*, *Michelia*, *Cinnamomum*, *Alseodaphne*, *Amoora*, *Canarium*, *Sterculia*, *Palaquium*, *Chickrassia*, *Mesua*, *Calophyllum*, *Lophopetalum*, *Aquilaria*, *Podocarpus*, etc ; the lower storey of bamboos of the species of *muli*, *dolu* and *Bambusa balcooa*, etc., palms and evergreen undergrowth. Natural regeneration is fair (only where bamboos are less frequent) mostly of *Palaquium*, but its condition is unpromising.

10. The climax sub-type III is storeyed high forest, characterised, as usual, by tall evergreen trees forming the bulk of the main canopy, single giant *Dipterocarps* (attaining heights up to 150′ and girths up to 20′) and similar trees or groups of them projecting well above the general level. Species in the overlapping middle and lower canopies are numerous evergreen and the mixture is very intimate,—only a few species forming small consociations. MACKARNESS, in his working plan of 1932 for LAKHIMPUR and SIBSAGAR, has appropriately distinguished four classes according to relative occurrence of the predominant species, *viz.*—

(*i*) *Hollong* (*Dipterocarpus macrocarpus*)—*nahor* (*Mesua ferrea*) type of storeyed high forest in which the former predominates in the upper and the latter in the middle storeys ; (*ii*) *makai* (*Shorea assamica*)—*nahor* type of similar forest on higher elevations and gravelly soil where *makai* has replaced *hollong* ; (*iii*) *hollong*—*jutuli* (*Altingia excelsa*)—*hingori* (*Castanopsis* spp.) type of storeyed high forest in which either *hollong* or *jutuli* predominates, *makai* is absent and

nahor few and far between, almost replaced by *hingori* in the middle storey; and (*iv*) the mixed poorer type where no one species clearly predominates. All these four classes are well represented in the Jaipur reserve, while Digboi and Disoi reserves largely come under the *hollong-nahor* type. Underwood is practically the same in all the above classes, (*i*) to (*iv*), consisting of numerous valueless and semi-important evergreens with some apparently suppressed young natural regeneration of valuable overwood species. As usual, several species of bamboos, palms, canes, climbers and epiphytes of sorts are numerous, and there is typically a ground cover of evergreen shrubs, herbs and bracken fern. Along river banks or low-lying swamps, strips of riverain forests are met with, where *hollock* (*Terminalia-myriocarpa*), *ajhar* (*Lagerstroemia flos-reginae*), *uriam* (*Bischofia-javanica*) and *outenga* (*Dillenia indica*), etc., form the main crop with canes and *Alpinia* spp. underneath.

11. The semi-evergreen sub-type IV in the plains reserves of the Brahmaputra valley covering small forest blocks, separated by extensive cultivation (under tea or paddy) or unclassed state forests, have been fully described in all possible aspects under three distinct zones of soil formation by PURKAYASTHA in his recent working plan of 1936. Past fellings were very heavy in these relatively accessible reserves with the result that the topmost storey now consists of widely scattered pole to middle-aged, in some places stag-headed (*e.g.* Barrajan, Hollangapara, etc.), *hollong* (*D. macrocarpus*), with an average height of 100′ and its associates, mostly of poor quality. The upper middle storey consists of scattered *Castanopsis*, *Cinnamomum* spp., etc. which overlap with the lower middle of *Trema*, *Mallotus*, *Macaranga*, *Meliosma*, *Echinocarpus*, etc., with *bojol* (*Pseudostachyum polymorphum*) or *kako* (*Dendrocalamus hamiltonii*) bamboos, evergreen shrubs or *Eupatorium* in relatively open areas. In well-stocked places, the predominant species of the overwood regenerate themselves fairly well, as is evident from plentiful natural regeneration of *hollong* and *nahor* (mostly in seedling stage) occurring in suitable patches (*e.g.* in Barrajan). Podumoni has a secondary crop where *hollong* and *nahor* are absent but *Castanopsis* and fuel species like

Turpinia pomifera are conspicuous, while Jokai and Dehingmukh indicate a different zone with *ajhar* (*Lagerstromia*) and *jutuli* (*Altingia*) in lower areas and *Dillenia, Bischofia, Mesua* (*nahor*), *Vatica, Eugenia, Echinocarpus*, etc., on higher levels. *Nahor* regenerates fairly well in well-drained areas even under close conditions of the canopy. In the rest of the areas regeneration of *morhal* (*Vatica*) and *Echinocarpus* is found in abundance.

12. The Sola reserve is slightly different with the *Altingia-Magnolia-Cinnamomum* association, where the evergreen species are conspicuous and well represented in the top storey and predominating in the lower with good growth. Natural regeneration is rare to moderate in localised patches. Bokajan, Diphu and areas in between are of an inferior type (with wet mixed species in water-logged places). Widely scattered tall trees (of about 80′ in height) of *bonsum* (*Phoebe hainesiana*), *hollock* (*Terminalia myriocarpa*), *amari* (*Amoora wallichii*), *ajhar* (*Lagerstroemia flosreginae*), *sam* (*Artocarpus chaplasha*), *simul* (*Bombax* spp.), etc., and other relatively valueless species stand over a dense underwood (30′ to 50′ high) of miscellaneous species, *e.g. Garcinia, Castanopsis, Dillenia*, etc., above heavy evergeen undergrowth and cane jungles. Natural regeneration of *sum* (*Machilus bombycina*) and *bonsum* is fair to abundant in places.

13. *Natural pests.*—Epiphytes and climbers are a serious pest, the former being more plentiful as the forests tend to be more evergreen, and the latter more profuse in the poorer and opener plains areas under sub-type IV ; while climbers are less under a closer canopy and on well-drained slopes of the foothills under sub-type III, or in areas with a dense underwood of bamboos, as in sub-type II. They are least frequent under sub-type I, subjected to frequent *jhuming* and consequent burning. In such open areas of secondary growth, either *Melocanna* bamboos or *Eupatorium odoratum* cover the ground to the exclusion of all other weeds.

14. *Nahor* (and to some extent *hollong*), both young and old, are frequently attacked by a root-fungus, ultimately causing their death. Pigs, deer and elephants are sources of damage to plantations and the usual defoliators and shoot-borers are present.

15. *Past history and methods of management.*—In *The Forests of India*, published in 1926, STEBBING remarked that Assam was "the most backward province in forestry matters" and that her position with respect to working plans did not go beyond the most elementary stage. The sal forests of GOALPARA had always been the show division where the first working plan of the province (by PERREE, 1906-7) was produced, while none of the evergreen forests under reference had any regular working plan before MACKERNESS' plan of 1932 for the foothills of LAKHIMPUR and SIBSAGAR and PURKAYASTHA'S plan of 1936 for the plains reserves. Jokai forests of about 7 square miles had, however, been worked under a working plan by CAVENDISH since 1910, which expired in 1920. A provisional working scheme and a separate plantation scheme for SYLHET were prepared only a couple of years ago. Regular working plans for SYLHET and CACHAR divisions are in preparation now for the first time. Blocks continued to be worked under selection fellings with a minimum girth limit.

16. As in most other provinces, the first steps towards forest conservancy were taken between the sixties and seventies of the last century, following in the wake of civil administration that had then been just settling down. The wasteful practice of unrestricted *jhuming* (shifting cultivation) by the local primitive tribes (*Nagas, Miris, Motoks, Morans*, etc.) had already depleted considerable areas of their valuable virgin forests. But the administration of this non-regulation province recognised that these hill tribes must be permitted to continue *jhuming*, which naturally proved a severe handicap to any contemplated measures of forest conservancy.

17. The advent of the tea planter in Assam, followed by the opening of railways towards the close of the last century, was a landmark in the history of the development of the province, in that these opened up vast waste-lands in relatively accessible areas richly endowed with forest. Tea estates and other companies floated at the time were vested with unrestricted occupancy right over forest-clad areas for their own use. The cumulative effect of this development was that wholesale lumbering quickly followed and the saw-mills of the Upper Assam Tea and the Dehing Companies continued

to draw on the forests along the Dibru river, lower Dehing river (Dehingmukh to Jaipur), etc., till the Forest Department was " but just in time to save great areas of fine timber from the lumberer." Inaccessibility and political reasons for abstaining from interference were responsible for safely locking up vast, compact evergreen forests in the upper reaches of the Naga and other frontier hills, except those which fell under the axe of the nomadic *jhumias*.

18. In the lower districts of SYLHET and CACHAR, timber used to be very extensively exported by river to the neighbouring districts of East Bengal, besides feeding the local saw-mills at Badarpur, Silchar, etc. Large batches of wood-cutters were allowed to enter the forests annually, and exploit timber, bamboo, canes and, worst of all, dug-outs by the most wasteful methods. The nominal restriction not to fell *jarul* and *nahor* under 4' in girth could hardly be enforced for want of proper supervision.

19. Most of the forest reserves were legally constituted in the eighties (1883—1888), Barrajan and Podumoni in 1916-17, while some as late as 1926 (Digboi). Timber exploitation was negligible up to 1911-12. In 1917, the Assam Oil Company removed some timber from upper Dehing reserve. From 1913-14 till recently there was heavy exploitation chiefly of *nahor* and *hollong* in all the accessible areas for the supply of railway sleepers. The Assam-Bengal Railway was at one time ready to accept as many *nahor* sleepers as the Forest Department was able to supply, and the Jaipur reserve was one of the main sources of supply. Besides, there was a contract with this railway for the supply of ten lakhs of softwood sleepers (*e.g.*, *hollong*, *jutuli*, *hollock*, *sam*, etc.) to be treated by the Naharkatiya treating plant.

20. In the plains reserves of sub-type IV, fellings under the so-called *selection-cum-improvement* system were still heavier; the stand retained is very poor indeed with a malformed, stag-headed, middle-aged crop interlaced with climbers and invaded by prolific bamboo whips or *Eupatorium*. The Sola forests of SIBSAGAR supplied a lot of firewood to the tea gardens around, as well as Hollangapara, which was worked under the method of *coppice-with-standards* (a sort

of fuel fellings), the firewood species being coppiced leaving the timber species as standards. Bokajan (Diphu reserve) was also heavily worked for sleepers about 1922, since left with inferior associates of valuable species in the upper storey, heavily laden with climbers right up to the top. In these plains, all *nahor* above 5′ in girth was exploited.

21. *Present system of management.*—The attainment of a normal forest is a distant ideal, the immediate scientific objects in both the above-mentioned working plans are the improvement of the growing stock and establishment of regular regeneration of valuable species to replace the present irregular forests. The objects of management are *first*, to meet local demands for timber and firewood, *secondly*, to meet the railway demand for *nahor* and mixed softwoods and, *thirdly* to create a demand for other important species hitherto unmarketable. Accordingly, MACKARNESS' working plan for the foothill areas prescribed provisional felling of the selection type, *i.e.*, preliminary fellings of the selection type combined with fellings for the improvement of the growing stock and encouragement of existing natural regeneration. PURKAYASTHA's working plan for the plains reserves has prescribed the uniform system in well or medium stocked (*hollong-nahor* type) forests near the foothills, where natural regeneration is possible by tending the advance growth and by regulated fellings in the overwood (*e.g.*, Barrajan), and clear-felling followed by artificial regeneration of valuable species in poorly stocked or open productive areas. In the alluvial plains away from the hills (Jokai, Dehingmukh, etc.), the selection system has been prescribed in areas where natural regeneration of *nahor* occurs in more or less gregarious patches in all age classes, with clear-felling and artificial regeneration in the remaining productive areas. The exploitable girth for *nahor* is 5′-6″ for the foothills and 5′ for the plains. For other important species 7′-6″ (6′ for *Lagerstroemia flosreginae* only), and for unimportant species only 6′. In recent years, the Assam Railways & Trading Co. have been continuing their timber operations, but the sleeper treating plant at Naharkatiya being closed, no large compartments have been worked. A certain amount of timber come out from fuel

coupes and clear-felled plantation areas; these, together with the timber coming out of unclassed state forests, serve to meet all local demands.

22. *Natural regeneration.*—The condition of natural regeneration of important species has been briefly referred to under the different types described above. In SYLHET and CACHAR (sub-types I and II), localised patches of fairly abundant natural regeneration of *Dipterocarpus turbinatus*, *Artocarpus chaplasha*, *Amoora* and *Palaquium* spp., etc., are met with under and around their seed-bearers in the remnants of high forest, provided there is no prolific undergrowth of bamboo. Their growth is progressive or stagnant according as they are exposed to light or not. Where the miscellaneous underwood or bamboos have been removed by *bona fide* permit-holders or otherwise, without causing any appreciable break in the upper, fairly closed, canopy; recruitment of seedlings has been fair to profuse, according to the degree of gregariousness of the parent trees and the opening of the ground cover. The future of these seedlings is largely dependent on the gradual opening of the overwood. In the 1931 and 1933 *gamari* plantations at Kamarchera (SYLHET), the few scattered standards of *gurjan* brought in enough recruitment of self-sown seedlings in the good seed year of 1933. The relatively exposed conditions of clear-felled plantation areas were favourable first to germination, and secondly to seedling growth below a nurse-crop of *gamari*. These have grown to 6′ in four seasons with vigorous leaders in relatively exposed places. Beyond sporadic attempts attending some of these self-exposed natural patches which are, however, few and far between (and whose importance and consequent tending are largely governed by personal factors), no systematic measures at conserving or improving such natural regeneration—not to speak of aiding further recruitment—appear to have been made in the forests of the Surma valley. Comparative remoteness, inaccessibility, sporadic distribution of important trees, lack of funds and of any planned policy must account for their apparent failure to come up to expectation.

23. As forests gradually improve northward in the Assam valley, better conditions prevail in the truly evergreen forests of

KAMARCHERRA (SYLHET) 1933 *Gmelina* PLANTATION: A SMALL PATCH OF NATURAL REGENERATION OF *Dipt. turbinatus* NOW 5'—6' HIGH, FIRST APPEARED IN 1933 BELOW A MOTHER TREE TO THE EXTREME RIGHT [*vide para.* 22].

EXPERIMENT ON CANOPY-MANIPULATION TO ESTABLISH EXISTING NATURAL REGENERATION OF IMPORTANT EVERGREEN SPECIES IN A *holiong nahor* TYPE OF FOREST AT DIGBOI (LAKHIMPUR) — [*vide para.* 23].

Photos: J. N. Sen Gupta.

LAKHIMPUR and SIBSAGAR (sub-type III) and to a less extent in their semi-evergreen plains (sub-type IV). Under and around seed-bearers, natural regeneration of *hollong*, *makai* (*Shorea assamica*) and *nahor* are abundant, *hingori* (*Castanopsis* spp.), *sam* (*Artocarpus*), and *hollock* (*Terminalia myriocarpa*) frequent, species of *Magnoliaceae* fairly frequent, *jutuli* (*Altingia excelsa*) and *amari* (*Amoora* spp.) rare, *gunseroi* (*Cinnamomum* spp.) very rare ; while other accessory species like *Vatica*, *Macaranga*, etc., also reproduce themselves quite well. Under existing conditions, the important species regenerate satisfactorily up to a point according as they find favourable conditions for seeds to reach the mineral soil, but height growth is checked by weeds, bamboos, climbers, etc., and absence of (or unfavourable) light conditions ; where conditions are favourable, seedlings grow up to saplings and poles unless again checked by climbers or dense over-wood, Systematic tending operations are, therefore, of primary importance. Most of the species are light-demanders, specially at the post-seedling stage, *Shorea assamica* is more shade-bearing than *hollong*, while *nahor* is the most shade-bearing of all the valuable species mentioned above and appears to grow better under close canopy in early years.

AIDED NATURAL REGENERATION OF SAL ESTABLISHED

BY R. N. DE, I.F.S.

Summary.— Observations made in the plots laid out in Goalpara shew that it is possible to establish in 4 or 5 years natural regeneration of sal by rains weeding and fire protection during the dry weather. Thatch as undergrowth is not necessary for sal regeneration, nor any sal soil, even completely covered by evergreen undergrowth, seems to be unfit for natural regeneration.

Readers of the *Indian Forester* are now probably quite familiar with what is called the Assam method or locally known as Kamrup method of sal regeneration by burning.

My notes deal with the natural regeneration of sal under the conditions prevailing in Goalpara forests *assisted by timely weeding during the rains, and fire protection during the dry weather.* Results

obtained from my observation plots during the last 4 years only are recorded here. It is obvious that my line of work has been entirely off the more orthodox method of burning.

In para. 396, page 63, of the current Working Plan for Goalpara division (Bor), it is stated as follows about Terai forests :

> "Natural regeneration is practically non-existent over the greater part of the area and if one is to judge from the ground vegetation, it is very unlikely that the soil will be for a long time in a condition favourable for the germination of sal seed and the development of the sal seedlings, though some improvement may be expected."

I took over charge of the division in January 1932, when the Plan had run for two years and in view of the conditions described above which were the worst of all in these forests, it was necessary to initiate experiments as to how best to regenerate these forests naturally (" with assistance ") without depending on burning and introduction of thatch (*Imperata*) which would take long. Prior to taking over charge of Goalpara, I had been holding charge of Garo Hills division where successful *taungyas* had been raised and the crux of the whole situation lay in seeing that the Garos weeded their *taungya* crop and sal lines in time during the rains. If sal lines were not weeded during the rains and the paddy or maize was allowed to smother them, the result was poor. Going over Kamrup division, I noticed that although sal regeneration was established in Boko, in grass over large areas, the process had undoubtedly taken a very long time, probably up to 40 years or more if counting of rings of the stumps be any guide to age.

Experience gained in these two divisions was mainly responsible for my decision in favour of weeding only during the rains and fire protection in the observation plots. My record of height measurements taken during the last four years shows that all height growth of the seedlings normally takes place between May and October and it is a mere waste of money to do weedings in the cold weather.

Two plots were accordingly laid out each half an acre in area, in the worst of the Terai conditions described before, in the summer

of 1932, when it was fairly certain that it would be a good seed year. All undergrowth including shrubs like *Morinda tinctoria* was cut and burnt, but no tree, big or small, sal or *kokat* (miscellaneous species) was cut. Although fire protection was abandoned in Goalpara some 20 years back there was practically no fire due to almost total absence of thatch.

Plot No. 1 Gangia

The undergrowth consisted of *sau* (*Pollinia ciliata*), *Eupatorium odoratum*, some evergreens and a little thatch (*Imperata*) confined to the southern edge of the plot. It was fenced to keep out grazing of cattle from villages about two miles away. The following operations were carried out:

1932 (*fire-protected after burning undergrowths*)

1. Cutting down the undergrowth on 11th April.
2. Burning of undergrowth on 18th April.
3. 1st weeding on 11th July } Average height of seedlings after
4. 2nd weeding on 22nd September } two weedings (approximately 1′).

1933 (*fire-protected*)

1st weeding on 13th May } Average height of the seedlings
2nd weeding on 15th September } after two weedings (approximately 2′). Fig. 1, Plate 55.

Kokat coppice cut down on 13th July, 1936.

1934 (*fire-protected*)

1st weeding on 19th June } Average height after two weed-
2nd weeding on 3rd October } ings (approximately 3′).

1935 (*fire-protected*)

1st weeding on 27th June } Average height after two weed-
2nd weeding on 10th September } ings (approximately 3′-9″).

A few trees standing over regeneration were cut down in April, 1935.

1936 (*fire-protected*)

1st weeding on 21st June
2nd weeding on 1st October } Average height after two weedings (approximately 5′).

Plot No. 2 Charaideka

This plot was in a lower lying locality than plot No. 1 and was considered to be worse on account of its having more profuse evergreen undergrowth. The following operations were carried out:

1932 (*fire-protected after burning of undergrowth*)

1. Cutting of the undergrowth on 13th April.
2. Burning of the undergrowth on 21st April.
3. 1st weeding on 15th July
4. 2nd weeding on 30th September } Average height after two weedings (approximately 1′).

1933 (*fire-protected*)

1st weeding on 4th June
2nd weeding on 18th September } Average height after two weedings (approximately 2′). **Fig. 2, Plate 55.**

Kokat coppice cut down on 14th July, 1936.

1934 (*fire-protected*)

1st weeding on 20th June
2nd weeding on 3rd October } Average height after two weedings (approximately 3′).

1935 (*fire-protected*)

1st weeding on 27th June
2nd weeding on 10th September } Average height after two weedings (approximately 4′). Fig. 3, Plate 56.

1936 (*fire-protected*)

1st weeding on 15th June
2nd weeding on 18th September } Average height after two weedings (approximately 5½′).

A few standing trees over regeneration were cut down in April, 1935.

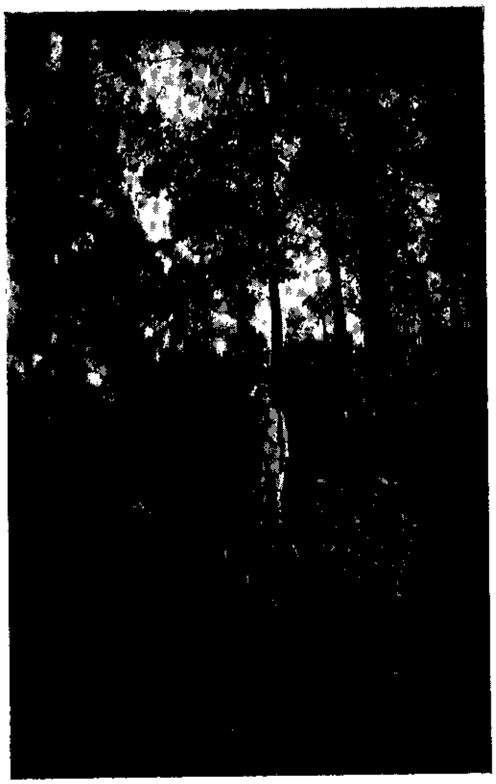


Fig. 1.

GANGIA OBSERVATION PLOT—SAL SEEDLINGS TWO YEARS OLD

Fig. 2.

CHARAIDEKA OBSERVATION PLOT—SAL SEEDLINGS TWO RAINS OLD

Fig. 4.

NATURAL REGENERATION OF SAL IN POLLINA CILIATA TWO RAINS OLD

Photos : R. N. De, I.F.S.

Photo : R. N. De, I.F.S.

Fig. 3.

CHARAIDEKA OBSERVATION PLOT OF 1932, FOUR RAINS OLD

These plots were inspected in January-February 1933 by the party of forest officers who investigated the problem of sal regeneration and Mr. H. G. Champion, on page 92 of his book "Regeneration and Management of Sal" remarks about the plots as follows :

> "De has shewn in some small plots near Kachugaon that by cutting and burning the undergrowth and low shade, regeneration of the year can be given an excellent start by rains weedings and may reach a height of 12″ despite a fairly complete high sal canopy."

Regeneration of sal in them is now established and this was done without having thatch (*Imperata arundinacea*) as soil cover and without any burning, except the burning of debris when the plots were first opened. Mention must be made of the fact that the few blades of thatch that were there initially spread steadily as years passed and now it is found all over the plots.

Simultaneously with the laying out of these plots, I had a strip 25′ × 3′ hoed up in each of the two plots and sal seeds broadcasted with a view to see if the seedlings would germinate and develop in view of the unfavourable remarks of the Working Plan Officer. Recruitment of 1932 having done very well, much attention was not paid to these, as it was evident that the soil could not possibly be so unfit for natural regeneration of sal and soil work was not necessary.

In the Haltugaon sub-division of the Goalpara division (now Haltugaon division), the evergreen condition of the undergrowth advanced much more than in Kachugaon and a very interesting experiment was started in 1919 in Amguri block at the initiative of the late Rai Bahadur U. N. Kanjilal who was then in charge of the division. A patch of about 20 acres of forest was opened up by cutting all *kokat* (miscellaneous species), 10 sal trees were left per acre ; subsequently reduced to 5 sal trees per acre. The area was burnt annually. From *Macaranga*, *Talauma*, *Meliosma*, fern and other evergreen species, the undergrowth changed to grass mostly *bata* (*Saccharum narenga*) and thatch (*Imperata arundinacea*), but the grass was so dense and high that no regeneration resulted. The

following description by the Working Plan Officer will give some idea of the area :

> " In the Amguri block there is an area in which an experiment was carried out to see if the opening of the forest combined with burning would induce natural regeneration to appear. The area is low lying and although some parts of it are promising, the water table is too high to ensure success. Most of the area is a wilderness of grass upon which stagnant water lies during the rains. This experiment may be abandoned and the area planted up with some other species that does not object to these moist conditions."

Here again, a small strip $25' \times 3'$ was cleared, soil was worked and sal seed broadcast in May of 1932, with a view to find out whether seedlings would develop and grow. I went to inspect this on an elephant in July, 1932, and was amazed to find the amount of recruitment inside the tall grass pressed by the elephant as it went. A plot was laid out in the grass and weeding was done in July 1932, and since then it has been weeded twice yearly during the rains and fire-protected. The seedlings are now established here also.

Sir Gerald Trevor, Inspector-General of Forests, in his note on tour of Assam forests in January 1936, remarked as follows :

> " In the above area (Amguri block), by rains weeding, he (De) has obtained a complete patch of regeneration. Similarly in Bamba, by pulling out *sau* grass (*Pollinia ciliata*), he has been able to obtain regeneration. One of his experimental groups, 4 years old (Charaideka, visited by Inspector-General of Forests), is fully established."

In the Babar sal, where the undergrowth is chiefly *sau* (*Pollinia ciliata*), plots were laid out in July 1932, and twice weeded during the rains and fire-protected. Sal has established itself there also.

Seeing the possibility of establishing natural sal recruitment by rains weeding and fire protection only in an area whether there is thatch (*Imperata arundinacea*) or not, I selected a plot in 1935 in the Babar sal, with chiefly *sau* (*Pollinia ciliata*) as ground cover where all trees other than sal were felled previously in course of *kokat* felling.

All small shrubs and creepers, *e.g.*, *Millettia auriculata*, *Acacia pennata*, etc., were cut and burnt early in April, and the *sau* was pulled out immediately before seed-fall between the 20th and 25th of May 1935. Two weedings were done during the rains and the area has been fire-protected since the first recruitment. The various operations and their costs are given below :

Area 10 acres.

		Rs.	a.	p.
1.	Clearing of the ground cover (*sau* and other weeds)	41	4	0
2.	Collection and sowing of seeds	1	14	0
3.	First weeding during July, 1935	96	4	0
4.	Second weeding during 4th week of September, 1935	39	13	0
5.	First weeding during June, 1936 (11 acres including the one acre plot taken later) ..	103	11	0
6.	Second weeding during October, 1936 ..	57	5	0

I should remark here that weeds seem to be getting less after two years of rains weeding.

No soil working was done, but all sal trees overhead not having borne seed, some seed had to be broadcasted in places. A thick carpet of seedlings resulted. Fig. 4, Plate 55 shows the growth of the seedlings after two rains.

During the cold weather of the first year (January, 1936), the plot was visited by the Inspector-General of Forests when the seedlings were about seven months old. Examination of the surround revealed the presence of many seedlings suppressed under *sau* and it was suggested by him to open out one acre of such forest, fire-protect it and do necessary weeding in the next rains after pulling out the *sau*. The Inspector-General of Forests remarked :

> " From an examination of the surrounds of some of Mr. De's experimental areas, it appears possible that even weeding in the second year after recruitment takes place may result in regeneration."

A plot was accordingly laid out and *sau* standing over sal recruitment was pulled out in April, 1936.

Two weedings have been done during the following rains also and the plot is doing well. The object of laying out the one-acre plot is to find out if we can dispense with the weeding in the first year which costs a fair amount, without damaging the growth a great deal.

Plots on the above lines have been laid out in different parts of the Babar tract, the oldest of them being three rains old and if the past progress be a guide to the future, it is confidently hoped that the seedlings would establish themselves in 5 to 6 years' time.

In the present working plan of Goalpara division, the provision of regeneration was based on 40 years' regeneration period and in Kamrup on a 20 years' regeneration period. It is not known if any Forest Division in India got natural sal regeneration according to plan and, as far as I am aware, nobody in Assam has established sal regeneration from the seed-fall to the stage of establishment by burning alone in five years.

With favourable labour conditions prevailing in Goalpara, I think it is possible to establish natural regeneration of sal by manipulation of the canopy and by rains weeding without fire, at a reasonable cost without waiting for a very long time, as laid down in the working plans. Thatch (*Imperata arundinacea*) was not present in most of the plots as a weed and if "aided" natural regeneration be the object, there is obviously no need to introduce thatch by burning the undergrowth as it is not a *sine qua non* of sal regeneration. I have taken pH values of the worst evergreen sal localities and the results are not much different from those of the best localities and if one can come to any conclusion no sal forest, however evergreen it might be, seems to be unfit for natural regeneration of sal.

EXPLOITATION OF THE ANDAMAN FORESTS

By B. S. Chengapa, P.F.S.

Part I.

Summary.—It deals with the description of the group of islands which go to make up the Andamans and describes various methods of exploitation which have been tried from time to time and those which are in force at the present time.

General description of the islands.—The Andaman Islands are 204 in number with an area of 1,508 square miles. Many of them are small and support not more than 30 or 40 trees. Some of them are just awash or are submerged at high tide and are a source of great danger to navigation. The main islands are North Andaman, Middle Andaman, South Andaman, Barataung and Rutland. These are separated by very narrow channels and may be regarded as forming a single island 156 miles long and about 15 miles broad. Other islands of importance are the Landfall Islands to the north, Interview Island to the west, the Labyrinth to the south-west, Porlob, Long Island, North Passage, Colebrooke and Strait Islands on the east, all hugging the main islands. The Havelock, Lawrence, Outram and Wilson Islands—mostly named after the Generals who quelled the Indian Mutiny—form Ritches Archipelago and lie 5-15 miles east of the Middle and South Andaman.

Coastal lines.—The coast line of the Andamans is very irregular with numerous and deep indentations giving rise to a large number of safe harbours for sea-going steamers. Indeed, some of them are so large that the fleet formed for the attack on Burma in 1824 was able to make its rendezvous at Port Cornwallis. Tidal creeks penetrate many miles inland and make timber transport extremely easy.

Configuration.—The Andaman Islands are very hilly with the main range of hills running north and south and rising to a height of 2,402 feet in Saddle Peak in North Andaman. From these hills ridges and spurs run in a confused manner enclosing narrow valleys or a mass of sweeping undulations. Level lands are rare except along creeks or river banks and the sea coast. Long Island and Interview Islands are fairly level.

Climate.—The climate is warm and equable, the mean temperature in the shade varying from 70° F. to 90° F. with a perceptible

touch of cold during December and January when fogs and chilly nights are common. February to April are sultry with very little wind. Average rainfall is about 150 inches, but varies from place to place. Precipitation generally occurs every month, though the bulk of it falls from June to October. Both south-west and north-east monsoons blow with regularity from May to October and from November to January respectively. These monsoons greatly affect exploitation and sea transport. At the beginning of the south-west monsoon the west coast becomes dangerous while a heavy swell sweeps up along the east coast. Therefore, unless one has intimate knowledge of local conditions it is difficult to make exploitation of these forests a success.

Forests.—Except 50 or 60 square miles cleared for the Settlement in the vicinity of Port Blair, the whole area is covered with a luxuriant growth of tropical jungle rarely found elsewhere.

The main types of forests are :

1. Mangrove forests. 2. Beach forests. 3. Low level evergreen forests. 4. High level evergreen forests. 5. Deciduous and semi-deciduous forests.

The mangrove forests (on tidal flats) are not at present of any commercial importance. It is estimated that about 160 tons of timber per acre are available and the area occupied is about 200 square miles in all, most accessible and easily worked. It is therefore most unfortunate that we have not been able to make use of this as yet.

The other types of importance are the deciduous, the semi-deciduous and the evergreen forests. These are confusedly intermingled throughout the islands and depend for their distribution almost entirely on the underlying rock and soil. The steep slopes and ridges are usually evergreen and the undulations deciduous.

The most important species are :

1. *Padauk* (*Pterocarpus dalbergioides*).
2. *Gurjan* (*Dipterocarpus* sp.).
3. *White Dhup* (*Canarium euphyllum*).
4. *Papita* (*Sterculia campanulata*).

Others of importance and now classed as miscellaneous species are :

1. *Koko* (*Albizzia lebbek*).
2. *White Chuglam* (*Terminalia bialata*).
3. *Black Chuglam* (*Terminalia manii*).
4. *Pyinma* (*Lagerstroemia hypoleuca*).
5. *Bombwe* (*Terminalia procera*).
6. *Didu* (*Bombax insigne*).
7. *Toungpeing* (*Artocarpus chaplasha*).
8. *Lakuch* (*Artocarpus gomezirana*).
9. *Thingan* (*Hopea odorata*).
10. *Ywegi* (*Adenanthera pavonina*).
11. *Lal Bombwe* (*Planchonia andamanica*).
12. *Lal Dhup* (*Parishia insignis*).
13. *Marble wood* (*Diospyros marmorata*).
14. *Sea Mohwa* (*Mimusops littoralis*).
15. *Hill Mohwa* (*Bassia butyracea*).
16. *Lambapathi* (*Sideroxylon longipetiolatum*).
17. *Lalchini* (*Amoora wallichii*).
18. *Lalchini* (*Calophyllum spectabile*).
19. *Mesua ferrea*.

Resources of timber and possibilities of the forests.—A linear survey was carried out in 1891 and counting all *padauk* 24 inches and up in diameter it was found that 84 sound trees and a slightly greater number of unsound and unmarketable trees were available per acre. It was also found that more than 20 per cent. of the sound trees were of inferior colour.

In 1905 a 20·8% enumeration of 154 square miles in North Andaman was made and a working plan was prepared. In 1912-14 a 19% enumeration of 400 square miles of *padauk*-bearing forests

in the South and Middle Andamans was made and a working plan was prepared. But only *padauk*, *pyinma* and *koko* were counted as only these species were then most in demand. The world war, however, brought many of the then lesser known species to the market and a steady demand for *dhup* and *papita* for match industry arose. The 1915 plan therefore soon became defunct and various rough estimates of the stand of timber were made from time to time to meet the exigencies of the situation. A clear felling and complete utilization of all materials over 185 acres showed 28·8 tons of timber per acre (Inspector-General's inspection notes).

Mr. Pearce, in his Consulting Engineer's report on forest exploitation in the Andaman Islands, 1928, estimated that after deducting the portion of the forests worked over and also other less productive areas, there are probably 1,870 square miles of forests available for commercial exploitation with modern methods of extraction. Calculating on the basis of 20 tons of sawn timber per acre, he thought that the total stand of timber is approximately 24 million tons and that working on a sustained yield basis on a 120-year rotation at least two lakhs tons could be felled annually. He also thought that, based on the usual theory that in a virgin forest the net volume is always stationary, *i.e.* that decay or loss in volume balances new growth or volume increment and taking an annual increment of 14 c.ft. per acre, a figure for only *padauk*, a slow-growing species, and deducting 30,000 tons that was then being felled, the net annual waste is at least 3 lakhs tons.

In 1927, however, a beginning was made by Mr. Mason to ascertain the timber resources in these islands and the American method of topographical survey and enumeration was introduced.

According to this method two perpendicular base lines, one running due north and south and the other due east and west, were run with compass and cleared 8 to 12 feet wide. Every 20 chains along these lines perpendicular lines, four to six feet wide, were cleared, thus dividing the whole area into 40-acre squares. At the intersection of every mile, *i.e.* at the corner of every mile square, a large

earth mound or a stone cairn with a stout wooden peg in the centre was erected. Along these base lines parallel strip lines were cleared at intervals of five chains and trees between these strips enumerated. The 40-acre squares were numbered and a sectional map 4″– 1 mile compiled roughly showing streams and ridges.

Levels were run along these lines with improved Abney level and a trailer tape. Contours at 20 feet intervals and also all other topographical details that affect exploitation, *e.g.* tidal creeks, swamps, streams, rocks, etc., were sketched in the field on a scale of 16″–1 mile (Ritches Archipelago was mapped on a scale of 8″—1 mile). Complete data on the forest vegetation was obtained concomitantly with mapping, enumerating all species down to 3 feet (breast height) girth. Every species was grouped in girth classes of 1½ feet up to 6 feet and in one foot girth classes up to 12 feet and over. Volumes in c.ft. were obtained by applying volume table figures prepared by measuring 5,250 trees felled in the course of extraction in the South and Middle Andaman Islands. These results were noted on a map 16″—1 mile showing the species and the quantity of exploitable timber available in each 40-acre section or its multiples and in a few cases in each acre section.

It was, however, soon found that a hundred per cent. enumeration and clearing of strip lines 4 or 5 chains apart for topography was slow and costly (Re. 1-6-0 per acre) and also unnecessary. Therefore the enumeration percentage was reduced and the strip lines for levelling were cut 10 chains apart. The average of the figures for enumerated areas was applied to the unenumerated areas and the total for the whole area calculated.

From these two maps—stock map and the topographic map—camp sites and rafting depots can be selected, the most economic layout of drag paths can be fixed, the number of elephants in each camp determined, giving due consideration to the fodder and water-supply available and the whole extraction planned in advance.

From the enumeration made, the mature growing stock in

unworked or lightly worked areas in South Andaman felling series was found to be :

		Tons.
Padauk	..	329,283
Gurjan	..	604,742
White dhup	..	450,137
Papita	..	408,710
White chuglam	..	89,911
Pyinma	..	123,290
Total	..	2,006,073

A rotation of 150 years was assumed for *padauk* and *gurjan* and 80 years for *dhup* and *papita*—based on ring counting in the case of *dhup* and *papita*. No rotation was determined for the remaining species but it was laid down that they should be felled only in areas allotted for the controlled species. The exploitable girth limit was fixed as usual at 9 feet and above for *gurjan* and *padauk*, 7 feet and above for *white chuglam, black chuglam, toungpeing, red bombwe, jhingam, thingan, koko,* 6 feet and above for the rest at the point of felling.

Sir Gerald Trevor, I.G.F., in calculating the possibility assumed that the mature growing stock of *padauk* should last 75 years, *gurjan* 45 years, *dhup* and *papita* 40 years and other species 60 years. Basing his calculation on this assumption, he fixed the annual yield at :

		Tons.
Padauk	..	4,000
Gurjan	..	13,000
Dhup	..	11,000
Papita	..	10,000
Miscellaneous	..	5,000
Total	..	43,000

Mr. Martin, W. P. O., calculated the yield by the Brandis method and arrived at very nearly the same figures.

No enumeration has been made recently in North Andaman felling series but Todd, in his 1906 Working Plan, showed a total of 36,295 trees or 91,884 tons. Assuming that this should last 75 years

(½ rotation) the yield was fixed at 1,225 tons *padauk*. Again for want of figures for other species, it was assumed that *gurjan*, *white dhup*, *papita* and other species are found in similar proportions to *padauk* as in Middle and South Andaman and the yield was fixed at :

		Tons.
Gurjan	..	3,000
White dhup	..	5,000
Papita	..	3,000
Miscellaneous	..	1,500
Total	..	12,500

These are to be removed as demand arises.

The yield, therefore, for the whole of the Andamans is :

		Tons.
Padauk	..	5,200
Gurjan	..	16,000
White dhup	..	16,000
Papita	..	13,400
Miscellaneous	..	6,500
Total	..	57,100

Early history.—Except for a brief period, 1789—1796 when under orders of Lord Cornwallis, Governor-General of India, a free Settlement was formed to put down piracy and the murder of shipwrecked mariners by the local savages, these islands have been unoccupied until the establishment of the Penal Settlement in 1858. Forest exploitation therefore may be said to have begun from this period with the clearing of land for occupation. But the timber was treated as useless and until 1870 Burma teak was imported for all substantial buildings. In 1883 a forest officer was deputed from India and a forest division was formed.

Mr. Ferrars, the first forest officer with 200 men and 16 elephants, carried on the local timber supply of about 2,000 tons per year, exported timber on a tentative scale, carried out survey work and started teak and *padauk* plantations. He organised a court of

exhibition at the Edinburgh International Exhibition of Forestry in 1884 and also at the Calcutta International Exhibition in 1883-84 and distributed free samples of timber in these places. This proved a useful measure in bringing Andaman timber to the notice of consumers and in creating a demand for hardwoods.

The system of working then was to girdle the useful kinds of trees preparatory to extracting them and then to clear the forest for cultivation. Extraction was supervised by convict warders taking the place of rangers and foresters. A small P.W.D. saw mill was in operation but was cutting timber mostly for their own use. Export was about 400 to 500 tons per annum mostly in *padauk* squares and telegraph poles, *gurjan* spars, tea boxes and a few planks. *Gurjan* oil—13,000 gallons per year—obtained by cutting holes and burning them in trees above 6 feet in girth was supplied to the Settlement for painting roof shingles in conjunction with earth oil and red oxide. 200 maunds of mangrove bark was also supplied for use in Phœnix Bay tannery. London and later New York were the chief markets for *padauk*. Vigorous attempts were therefore made to develop the London market to its full capacity. Though considerable profit was being made in this market it always needed selected timber. Facilities for direct shipping were rare. Indian markets, however, much less exacting, soon developed and a steady demand for Andaman timber arose. It therefore became necessary to work *padauk*-bearing forests upon a more extended scale beyond the range of the Settlement operations at Port Blair. A locality on the northern portion of Shoal Bay and its western coast was selected and extraction started in 1886.

A large stock of mature, frequently gigantic timber, the growth of centuries of undisturbed production was usually found. Therefore the main question at issue was (Government of India, No. 181 F., Calcutta, the 27th February 1889) to find a profitable market for the stored up surplus as well as for the annual production. Special stress was laid on the introduction of teak into the Andamans. Until these were settled a working plan was not considered necessary (F.A.A.R. 1887-88). The Selection System or better termed "Selective

System" was therefore introduced and extraction organised accordingly.

From the very outset the problem of extraction of timber in the Andamans has been twofold, *viz* :

1. Land transport and 2. Water transport.

Land transport—early period.—Twenty-seven elephants and 22 buffaloes began to drag logs from stump site to tidal water in Shoal Bay. *Padauk* was converted green by hand labour, mostly into squares, and other species were girdled.

As demand from various markets arose the animals were made to work harder. Their rest for two days after every three days' work was cancelled and their dry weather remission was also stopped with only such remission as they obtained when incapacitated by harness galls and overwork—a condition still prevalent in the Andamans. To reduce cost of extraction (Rs. 7-10-0 per ton of 50 c.ft.) the elephants were deprived of their grain ration—50 lbs. of paddy per day. The result, however, was disastrous ; seven out of 27 elephants died in one year (F.A.A.R. 1886-87). Many more died in subsequent years of overwork or *Sukha Zakarbad* or *Lalbukhar* as the elephant "doctor" called it—not a qualified man. He also declared that *Lalbukhar* was a well-known disease and was always fatal and that it was a disease which could not be foreseen or guarded against (F.A.A.R. 1901). Their grain ration was therefore restored and they were allowed rest on all Sundays and also on Wednesdays during hot weather months. (This doctor, however, was killed by one of the elephants in 1901. Contrary to orders he fell asleep on the back of one of the young elephants that took fright at the sight of a wild pig or a cat and bolted. In doing so the elephant shook off the doctor and accidentally placed its foot on the doctor's chest, causing his death.) Large *pilkhanas* were also constructed to house sick elephants.

To keep pace, however, with the increasing demand it became necessary to purchase more elephants and also more buffaloes. Buffaloes proved unsatisfactory and elephants were dying in large numbers or were suffering from sore feet. Many of them were

always on the sick list. It became therefore necessary to find other means of extraction. A tramline—18 lbs. rails, 24 feet gauge—1½ miles long was first constructed in 1890 at Dhani Khari at a cost of Rs. 15,683—including the cost of rails (convict labour was employed and this was free, except for the cost of food). Four men for each truck or eight men per pair of trucks were engaged to push the trucks up and down. Buffaloes were employed to haul up the trucks on uphill gradients and also to cart logs to creeks. This proved efficient and more tramlines were constructed at very much the same cost per mile. A pole tramway was also constructed in 1891 at Aniket. This became unworkable in the rains and proved very expensive with frequent derailments. It was therefore abandoned. Elephants and portable tramlines, however, proved very efficient.

Land transport—pre-war period 1900—1914.—Though tramlines proved efficient and the dragging distance was reduced, elephants still continued to die in large numbers mostly due to overwork. The Government of India became alarmed and in their No. 99-242/2-F., dated 23rd January, 1902, remarked that "the management of elephants, upon which the Forest Department work so largely depends, appears to leave room for considerable improvement, since it is quite inexcusable that an animal should be killed by overwork." Endeavours both in Calcutta and Rangoon to secure the services of a man of the Veterinary Assistant class as elephant doctor failed. An old mahout was therefore engaged as doctor until 1920 when the services of the present Veterinary Officer were secured and the management of elephants placed on sound lines.

The frequent death of elephants, however, gave still further impetus to the construction of tramlines in the Andamans. A steam tramway in Wimberly-Gunj, 6 miles long, 24 inches gauge, 18 lbs. rails was constructed in 1903-4 at a cost of Rs. 99,550 connecting Shoal Bay with Port Blair harbour (free convict labour). Before the end of this period two steam locomotives, 49 large and 15 small wooden trucks and 16 iron trucks were in operation over this line to transport timber and fuel. A maximum gradient of 1 in 75 was allowed and the locomotive pulled 8—10 logs per trip. A gradient

of 1 in 75 is too stiff for the type of engines then used and may have caused its subsequent failure.

In 1909 when sea transport was not available all timber from Barataung and the adjoining islands was brought to Port Blair harbour through a canal from Patatung creek into Port Meadows, thence through another canal into the Bay, north of Durataung, thence *via* Potama channel, up Shoal Bay and over Wimberly-Gunj tramline to Port Blair harbour. Similarly, timber from Rutland Island and the West Coast of South Andaman was towed to Constance Bay, rafted up Temple-Gunj stream and then over Aniket tramline 9 miles to Shaitan Khari in Port Blair harbour.

With the improvement of water transport, however, especially after the purchase of the steam vessel "Rosamond" these lines were more used for transporting fuel for use of the Settlement and were eventually abandoned and a part of the Wimberly-Gunj line was lifted for use at Bomlungta.

In 1914 freshets in larger streams were made use of to float down timber. This was accomplished by keeping a collection of logs ready near the stream. As soon as a flood was expected, these were pushed into water and caught by means of a boom made of *papita* logs lashed together and anchored to trees at either end. These booms were placed across the stream where the current was sufficiently slack, usually about a mile below the upper limit of the mangrove. For this purpose, heavy sinkers like *gurjan* and *pyinma* were girdled at least six months before felling for making them buoyant in water.

A road scheme at an estimated cost of Rs. 2,50,000 excluding cost of bridges and culverts for 8 feet metalled road 60 miles long from Porlob to Stewart Sound with a branch to Lewis inlet was put forward in 1914 and 6 miles were constructed from Bomlungta valley at a cost of Rs. 19,454. A large portion of this road was later utilized for tramline construction in 1916.

The war period and the post-war period, 1915–1922.—In 1915 the road scheme was superseded by a proposal to take out *padauk* timber from inland areas with the aid of monorails and buffaloes similar to those then in use in Siam (*Indian Forester* for May 1916).

This, however, was abandoned in favour of a two feet gauge through tramline from Bomlungta to Base Camp in North Andaman. The construction of this line was started simultaneously in 1916 at both ends—from Bomlungta proceeding north and from Base Camp proceeding south. Eighteen lbs. rails were used and a maximum gradient of 1 in 400 was allowed. Sleepers and bridge timber sawn at the mill and supplied free were used in this line and before the end of 1922 a length of 6¾ miles in Bomlungta at a cost of Rs. 1,88,511 and a length of 1⅛ miles in Base Camp at a cost of Rs. 54,605 were brought into working condition. (Convict and also free labour imported from Ranchi were used at Bomlungta and only free labour at Base Camp. Convicts were paid annas five per diem and free men Rs. 15 per month and their passages both ways were paid by the department.)

These lines were, however, abandoned in 1922 for reasons not very clear now and written off in 1928.

Land transport—later period, 1922—1934.—In 1921 Mr. C. S. Martin, then Consulting Forest Engineer to the Government of India, after a visit to the Andamans, recommended construction of metre gauge railways and introduction of caterpillar tractors. He stated that this would reduce cost of extraction by 50% and thought that elephants should be replaced as far as possible by machinery as large tracts of forests were unsuitable for elephants owing to the scarcity of water and fodder supply. Mr. Bradley, then Chief Forest Officer, however, was opposed to the introduction of American methods of logging and thought that the problem of fodder supply could be solved by raising a fodder crop artificially. He also thought that the method of extraction from stump site to water's edge by elephants and buffaloes was " simple and efficient and suited to prevailing conditions. Such power is highly portable, practically self-supporting, suited to the type of labour available and as cheap as any more rapid mechanical method is likely to prove. " Mr. Martin's scheme therefore did not eventuate.

In 1921 the clear felling system was introduced. It became necessary to concentrate elephants in small areas. To avoid what

was then an imminent danger of congestion of elephants in too confined an area a skidder mounted on a wooden lighter was introduced in 1923. It was tried at Alexander Island and was afterwards converted into a steam pile driver for driving piles in deep water. (Mr. Flewett subsequently converted this into a loading machine for loading logs in steel barges for transport to Chatham from forest camps superseding a slow and costly process of loading with crab winches mounted on a fixed wooden gantry. This, however, is now being replaced by an arrangement for loading logs direct in steel barges and ships without recourse to rafting, resulting in a saving of more than Rs. 4,000 per month on rafting apart from losses of timber in floods in towing.)

The clear felling system was soon found unsuited to the Andaman conditions and the selection system, aptly termed by Mr. Mason "picking-the-plums system," was again introduced. Elephants continued to be the main dragging power, their number was raised to 94 in 1927 and buffaloes were again introduced. Yet the need for studying means of extraction other than by elephants became more and more pressing as the operation extended and as the more accessible areas were worked out. It was found that not only was the number of elephants, which the forest could support, limited, but the area which could be economically worked by elephants was also limited. "Therefore unless other means of extraction other than by animals can be provided, not only can there be no further expansion but it will not be possible to maintain even the present scale of operations" (F.A.A.R. 1927, para. 49). It was also found that with only animal power for extraction no better method than "picking-the-plums system" for working these forests could be evolved. The minimum girth limit was the only silvicultural rule that was being followed (F.A.A.R. 1928). Therefore, the services of Mr. Pearce, then Logging Engineer, Madras, were obtained to study the problem of extraction in particular and to advise generally on exploitation and working.

Mr. Pearce, after a careful study in 1928, found that "the Andamans have now reached the cross-roads in forest exploitation.

They must either take the road of reorganisation, improvement and expansion or the turn leading back to restricted progress, lessened production and decreased profit. There is no middle way; the local officers are very doubtful of maintaining even present production with the old organisation and method. While feeling the way and getting Andaman timbers established on the market the present organisation served its purpose. But now the Andamans have progressed to the stage where the old organisation cannot for long continue to cope with the problems of forest exploitation. Nor can the present inadequate staff continue to overwork; like a machine it will wear out. The only reason the present organisation runs at all is because it is exceedingly fortunate in personnel." Mr. Pearce recommended topographical survey and enumeration of all workable areas and introduction of—

(*a*) " Roader and elephants " for all coastal and creek areas.

(*b*) Yarders, better known as " Skidders," for all areas of difficult topography.

(*c*) Combination system for interior areas, and considered steam-driven engines most suitable for the Andamans.

He suggested that the " Roader "—a wide drum-logging engine with big line capacity, the largest carrying 8,100 feet of $1\frac{1}{2}$ inch diameter wire rope main haul line and 21,400 feet of $\frac{5}{8}$ inch haul-back or out-haul line, powered by a two-cylinder 14 inches $\times$ 14 inches steam engine—should be mounted on a barge for use along tidal creeks or on a wooden sledge for working along the shore. Using the " Reader " to pull logs in from a distance of up to $1\frac{1}{2}$ miles along parallel or radiating straight lines and elephants to drag logs a short distance from each side to these lines, he hoped to double or treble the output per each elephant.

For areas of difficult topography he suggested a Skidder (Yarder) that carries 1,500 feet of main line.

For interior areas he suggested: Combination of " Roader " and Skidder, the latter to feed the " Roader " replacing elephants in difficult country, thus covering a greater area along the creeks and coastal areas. For logging interior areas or for entire islands meter

gauge railways—5 miles per square mile section—with Skidders to yard to rail and to load were recommended. For areas where light railway construction may be expensive "Yard and Swing" was recommended, the same Skidder that does the yarding or a similar machine doing the swinging or hauling of the collected logs to the next spar tree and eventually to the tidal creek or to the light railway. He also thought that where conditions are favourable for elephants, they can always be used to advantage in conjunction with Skidders and that the combination of the two would probably be cheaper than either alone.

Mr. Pearce's specific recommendations for Interview Island, 26,528 acres, a fairly level country, were: A network of light railways 20 chains apart—5 miles per square mile—radiating from a temporary jetty, timber to be yarded to the rail and loaded on trucks by high lead Skidders, the loaded trucks to be hauled by buffaloes or light locomotives. Estimated cost per ton of timber with one Skidder and 1,000 tons monthly Rs. 6 and with two Skidders and 2,000 tons of timber monthly Rs. 5-12-0.

This excludes overhead charges and also rafting.

Capital for 1,000 tons monthly Rs. 1,00,000 (one Skidder).

Capital for 2,000 tons monthly Rs. 1,57,000 (two Skidders).

Mr. Pearce, however, pointed out that "it should not be construed as meaning that I am advocating introducing or carrying on mechanical extraction on all four or five areas at once. Actually only one Skidder should be purchased in the beginning and the second after crews have been trained," and also that "it should not be supposed that the cost of extracting timber from the whole of the Andamans will be the same as the cost I have given for the easier areas selected for initiation of new methods. Skidding cost would be about the same, but logging the interior of the Great Andaman and the areas behind the fringes already worked will be much more expensive in land transport cost. Interview and Long Islands are exceptionally easy from the standpoint of railway construction, but in most other areas the cost would be considerably increased." (Consulting Forest Engineer's Report 1928.)

It was also suggested that contract extraction should be encouraged to increase the South Andaman outturn.

These recommendations were accepted and a beginning in mechanical extraction with a Skidder and light railways at a cost of Rs. 1,57,441 under the supervision of Mr. Pearce was made in Interview Island in 1930.

The South Andaman extraction was given over completely to contractors at Rs. 5 per ton delivery at tide water from which they could be towed to forest ships by departmental motor boats or Rs. 5-12-0 if delivered alongside the forest vessels. ***Padauk*** logs and *padauk* squares were paid for at higher rates. Elephants were supplied free of charge to these contractors, only the cost of feeding and that of attendants being paid by them.

The cost of departmental extraction delivering alongside forest vessels was then Rs. 5-11-6 per ton of timber in South Andaman and Rs. 8-10-5 in North Andaman, because of free imported labour.

The Skidder began to operate in December 1930 and extracted 400 tons of timber to begin with. From the Skidder, nine well cleared lines, 20—30 chains long, 12—15 feet broad, radiated in all directions for running the sky-line cable way. Between these lines, all logs were dragged by elephants to these cleared lines—the outturn increased to 1,215 tons in May. However, due to worldwide depression in the timber trade this operation was closed in 1931 and was eventually abandoned. Though it is not a fair comparison since the Skidder operated only for five months, the cost per ton of timber produced was very much more than by elephants alone. The Skidder operated within half a mile radius of tide water.

After the Skidder was abandoned North Andaman extraction was also handed over completely to contractors on similar terms as that in South Andaman. The annual outturn was about 40,000 tons and in peak years 1931, 45,746 tons, and 1932, 45,142 tons.

It soon happened, however, that coastal and creek areas were exhausted and one of the contractors who was responsible for a large outturn of about 25 to 30 thousand tons per annum terminated his contract at the close of 1933 (September). The question of extraction, therefore, became a serious problem again and applications for further contracts were invited.

(To be continued.)

BIOLOGICAL CONTROL OF FOREST INSECTS

By J. C. M. Gardner, I.F.S.

In virgin forest life tends to be in a state of equilibrium. Insects feed on the trees but do not increase to great numbers owing to several factors, one of the most important of which is their use as food by other insects; these carnivorous insects are known as parasites and predators. It is true that local and temporary outbreaks may occur in natural forest largely due to abrupt weather changes but these are rapidly brought back to normal.

The tendency in forestry is to convert natural mixed forest into pure stands of useful species, the useless species having been eliminated. The result of this is that the optimum conditions for the multiplication of the harmful insect fauna of the useful tree are created. At the same time the ecological conditions of the predators and parasites are interfered with; for example many of these feed on several species of insect and the reduction of their possible hosts to one or two species may make their successful continuance throughout the year precarious. The harmful species multiply excessively and epidemics result.

At this stage the entomologist is called upon to apply control. Possible methods can be classified as Chemical, Mechanical, Silvicultural and Biological. The first two are rarely applicable in forestry owing to the high cost; for example it is often profitable to spray with poison a low-lying agricultural crop but similar action in a large forest plantation is usually out of the question. Silvicultural control involves several possibilities: the avoidance of large areas of non-gregarious trees in pure stands, the correct choice of species in mixed stands; choice of species for undergrowth and so on.

We now come to the fourth method, biological control; of the several factors here, we are giving special attention to the encouragement of insect predators and parasites. The predator is active both in the mature and immature stages; an individual typically kills

Note.—Address delivered at the staff meeting of the Forest Research Institute, held in the Board Room on 12th July 1937.

numerous insects for food and these insects need not be of one kind. The typical insect parasite, on the other hand, has only slight powers of movement in the larval or feeding stage ; the larva is a weak, soft, legless and maggot-like creature which is, however, admirably fitted to feed on the tissues of its host. Active movement is not necessary since the larva on emergence from the egg finds itself either in or on the body of its host ; all it has to do is to feed. The adult stage is very different, nearly always extremely active and winged ; some related to wasps, others with a considerable resemblance to the common house-fly. There are many thousands of species each with its own peculiar habits.

While predators are mainly polyphagous, parasites vary. Some species attack only one species of host ; others several allied species ; others have a still wider range of hosts. The parasite may attack the egg, larva, pupa or adult according to its species. Another class of parasites, called hyperparasites, attack primary parasites and are therefore injurious. Even minute egg-parasites are themselves attacked by still smaller hyperparasites.

There are two rather different cases in which the possibilities of biological control have to be considered. First, when the pest has been introduced from another country and, owing to favourable environment and the absence of its natural enemies, has got out of hand. Second, where the insect is indigenous and tolerable under natural conditions but has reached pest status owing to the artificial creation of its optimum environment.

The first case, that of the introduced pest, does not occur in Indian forestry but as most of the large-scale work on biological control deals with this aspect, some remarks may be of interest. The United States of America have suffered severely from introduced pests ; nearly one half of its major pests have been introduced, usually from Europe. To take one of these, the Gypsy Moth. This is fairly common in Europe, but is of no great importance owing to heavy parasitism. It first appeared in Massachusetts in 1867, having been brought from England, I have been told, by an amateur collector who allowed one or two moths to escape. Needless to say its own

particular parasites were not brought too. Twenty years later the moth had become a serious pest with a wide range of food-plants. Control methods were put into force and in 1900 the moth was so scarce that the legislature of Massachusetts refused to continue the programme, against expert advice. Abandonment of the work for four years allowed the pest to gain such a hold that the State has been spending over a million dollars a year to alleviate the trouble. A serious control campaign was started in 1905, special attention being given to the introduction of parasites and predators from Europe, where several laboratories were set up. Millions of individuals have been imported and at least fifteen species have established themselves. But the pest has not yet been eradicated.

In connection with this gigantic project I may refer to a case where something like factory methods are used in the Gypsy Moth laboratory at Melrose. An introduced parasite attacks a proportion of each batch of Gypsy Moth eggs; it is desired to obtain a large number of these and to distribute them over the attacked areas. The eggs are laid in a mass, matted over with hairs. First the egg-clusters are broken up and fed into a machine with two canvas-covered discs, one of which revolves; the eggs are thus gently cleaned and hairs and débris are drawn off by air. The mixed eggs are then fed into another machine, which consists essentially of an inclined chute with a cross-bar at the bottom, and a partitioned receiver. On meeting the cross-bar, the eggs bounce; parasitised eggs are not as good bouncers as the sound eggs and therefore fall into the nearer partitions, whence they are removed and distributed in large numbers; the unparasitised eggs fall into the further partitions and are afterwards destroyed.

Among the many definitely successful instances of biological control are: (1) The cottony-cushion scale accidentally introduced into California, became a virulent pest of orange and lemon. A mission to Australia resulted in the importation of a predacious coccinellid or lady-bird beetle which reduced the pest to insignificance in less than five years. This identical method has been repeated in other parts of the world. (2) The control of several severe sugarcane pests in Hawaii by introduction of parasites and predators by Muir,

entailing long journeys in Australia, Java, China and elsewhere. (3) The check of enormous damage by the European larch sawfly to Canadian forests by the introduction of parasites from England.

The second class of epidemic, due to the increase of an *indigenous* insect owing to the artificial creation of a very favourable environment, contains many of the more important Indian troubles. The Entomological Branch is now experimenting in Biological Control of teak defoliators in Nilambur, Madras, and of shisham and mulberry defoliators in the Punjab; these are tolerable defoliators under natural conditions but serious under plantation conditions. The geographical distribution of the parasites of these pests does not always coincide with that of their hosts. For example several parasites of the teak defoliators occur in Burma but not in Nilambur and *vice versa;* exchange is therefore being made, large numbers being reared under laboratory conditions for despatch. One parasite species (*Cedria paradoxa*) from a teak defoliator in Dehra Dun was found to be capable of attacking the larvæ of mulberry defoliator in Dehra. It has never been found in the Punjab plantations. Large numbers, therefore, were reared in Dehra and this month (July) over 15,000 individuals were taken to the Punjab plantations and released.

In addition to this introduction of parasites to new localities, efforts are being made to increase the numbers of certain parasites already present.

The operations involved in work of this kind are intricate. Each species has its special requirements; some will live in cold storage (which is necessary to delay activity in transport) only as pupæ, others will travel well as adults; some will attack only host larvæ of a certain size, others eggs and so on; hyperparasites must be eliminated.

In conclusion, it is apparent that insects must be considered when forest operations are planned. Harmful species must be discouraged and parasites and predators favoured. The principles involved are discussed by Beeson (*Indian Forester*, 1934, p. 672, "The Biological Control of Teak Defoliators.")

EXTRACTS

THE TECHNICAL QUALITIES OF WOODEN SLEEPERS COMPARED TO THE QUALITIES OF METAL OR CONCRETE SLEEPERS

By M. J. Campredon

Head of the experimental laboratories of the National Institute Du Bois.

A.—The technical qualities of wooden sleepers.

At the present day the wooden sleeper appears to be the one which responds in the most perfect manner to the technical requirements of the case. Let us examine its qualities. For a relatively light weight it occupies a considerable volume permitting—

(*a*) a good seat in the ballast, stabilising transverse movement in the sleeper;

(*b*) a large surface which distributes the load, thereby loosening the pressure on the ballast.

2. Made of an easily worked material it is easy to obtain various lengths and sizes suitable to the divergent requirements such as main lines, secondary lines, crossings, etc.

3. It permits the ready attachment of rails and resists the lifting strain on the spike.

4. It gives remarkable elasticity which can be increased by bearing plates between rail and sleeper and a good resistance to vibration caused by the passage of trains. Wood does not present the inconveniences of metal due to fatigue.

Such are the technical qualities of the wooden sleeper. This total of qualities does not appear to have been reached at present by other classes of sleepers.

On the other hand the wood sleeper has the following defects:

(1) It has a marked tendency to split, especially near the rail seat, a tendency which can be minimised by the use of S irons on the end of the sleeper, or by the use of a transversal bolt which, however, increases the cost of the sleeper. This fault is formed especially in sleepers of pine and beech.

(2) It lacks durability, minimised to some extent by preservative treatment, but in spite of this remaining the chief defect of the wooden sleeper.

(3) It requires, on account of the play of the spikes in the wood, frequent retightening of the spikes, which is costly.

B.—OTHER TYPES OF SLEEPERS.

1. Attempts made to substitute a concrete for a wooden sleeper do not appear for a moment to have given satisfactory results. In order to reduce weight it has been necessary to reduce sizes and by thus reducing stability to introduce special types of construction which enhance the price. The poor elasticity of concrete resists badly the vibrations caused by the passage of trains and shows a tendency to disintegrate. The action of frost seems to be equally harmful and finally the attachment of the rails is difficult and requires special arrangements.

Attempts which continue till to-day for instance on the Midi Railway Company do not appear to have given any results of general interest.

2. Metal sleepers represent a much more acceptable solution. Presenting somewhat less resistance to the ballast by reason of its smaller dimensions than wood nevertheless the metal sleeper offers equally good elasticity and an excellent resistance to vibration. The fixing of the rails, although less easy than with wooden sleepers, has been solved in several interesting ways although these have added to the cost.

As a disadvantage of the metal sleeper must be noted the excessive rusting in a wet or maritime climate. Much more important than this, however, is the fact that varied lengths and sizes are much more difficult to obtain than in the case of wood. On permanent ways equipped with metal sleepers it is necessary to resort to wooden sleepers for crossings.

C.—GENERAL CONCLUSIONS.

It follows from the preceding consideration that the substitution of the wooden sleeper by the metal or concrete is not to be commended on purely technical grounds. On the other hand it is economic considerations which will decide the question.

In France the menace of the eviction of the wooden sleeper does not appear to be serious. The State has only made small experiments in this direction on secondary lines at the demands of the manufacturers.

In Belgium, on the contrary, where economic conditions are different, a great effort has been made by the metal interests to obtain a substantial footing.

Indo-China, where the metal permanent way has recently become of some importance, can equally be given as an example of the influence of particular conditions on the evolution of ideas. Although possessing sleeper woods in considerable quantities the administration has equipped all the new lines with metal sleepers. The reason being that construction was carried out on a budget of payment in kind, and it was more economical to import metal sleepers. It may be noted in passing that in Annam on the sea coast metal sleepers are rapidly rusted and have had to be replaced by wooden ones.

D.—Future of the wooden sleeper.

It appears that the wooden sleeper on account of its characteristics will for long maintain its technical superiority over metal or concrete sleepers. But in spite of such technical superiority on account of the improvements which are possible in future the wooden sleeper cannot maintain itself against its competitors unless economic conditions are equally in its favour. On this account the question of durability is of paramount importance. It is towards an increase in the life of the sleeper either by a fight against disintegration or mechanical wear or tear or by the perfecting of process of wood preservation against decay that our efforts must tend. Price is directly bound up with the question of durability. The life of a metal sleeper cannot be fixed, with precision, as we are still in the experimental stage. But it is probable that on this ground the battle will be fought out. It is therefore of fundamental importance if the wooden sleeper is to win that the quality of sleepers should receive the strictest attention. After this the life of the wooden sleeper will depend on the preservative treatment given them. It is towards such methods of conservation that we should proceed in future if we wish to maintain the superiority of the wooden sleeper.

GUJRAT VILLAGERS' SELF-HELP

Twenty years ago the Dwara Kas left its channel about five miles above its junction with the Chenab River, and cut a fresh channel through the lands of 14 villages, destroying in the process about 6,000 acres of good agricultural land. Since then the villagers have petitioned every visitor, as they say themselves, they have stopped every tonga and motor to ask for help, but no help has been forthcoming from outside. Realising at last that the only help they could get was amongst themselves, they have banded together to supply free labour in the building of an earth *bund* which it is hoped will deflect the torrent back into its old bed again.

The site of this *bund* is nine miles from Gujrat between the old towns of Jalalpurjatan and Saleempur. It consists of a main *bund* some 600 feet long by 14 feet high, with four spurs or groins which point out into the sandy torrent bed in order to deflect the force of the torrent away from the main *bund*. The faces exposed to torrent action have to be revetted with a layer of sand-bags, and a considerable amount of planting is being done with shisham trees, *banha* bushes, *kana* grass clumps and ***agave*** or Spanish bayonet plants in order to bind the sandy soil on and around the ***bund***.

This work has been organised by the Naib-Tahsildar and other local influential men under the guidance of a forest officer who has recently been placed by Government on special duty in Jhelum and Gujrat to encourage and develop such work, combined with the conservation of grazing lands.

At first sight there may be no obvious connection between engineering works for the control of streams and the control of cattle in grazing lands, but in practice they are definitely linked together. Practically all torrents which are actively destroying our most valuable *barani* cultivated land by cutting away banks and dumping enormous quantities of useless sand, originate from the gently sloping lands of the foothills. The water falling there should be caught and held by the grass and shrubs which keep the soil porous, but unfortunately owing

to persistent grazing these lands are now bare and exposed. Whatever rain falls rushes off at once, carrying away with it enormous quantities of eroded material from the exposed soil.

Hence it is essential that any attempts at flood control cannot stop with engineering *bunds* in the lower reaches, but must concentrate also upon getting better soil protection by means of plant cover in the upper reaches of each torrent which is doing damage.

Unfortunately, it is often a different set of people whose livestock is damaging the upland slopes, and they do not care what losses are suffered by the villages a few miles downstream through flood and erosion. This is where Government can help, and is helping, by detailing officers with a sound knowledge of the villagers' livestock problems to persuade them into following a less wasteful and harmful use of their grazing grounds.

This effort at self-help in Gujrat will doubtless become a model from which many similar undertakings will be copied, because the amount of cultivable land which can be recovered and improved by such stream-training projects is very great indeed. In Jhelum district alone *about two-and-a-half square miles of cultivation is being destroyed each year* by torrent action and by the spread of sand from torrent beds.

Government obviously cannot afford to undertake such work in every village, but much can be done by the practical encouragement and organisation of self-help. With Government supplying an organiser with the necessary technical knowledge, plus much tact and patience, and the villagers each doing their bit under a system of voluntary self-help, the shortage of cultivable land and complaints about unemployment would to a great extent be cured.—(*The Civil and Military Gazette*, May 16, 1937.)

SHORTAGE OF EPHEDRA

It is only some twelve years ago that this commodity was introduced into the European markets, and since that time its valuable properties have gradually gained recognition. Consumption of ephedra during the past few years has increased enormously, and

to-day it is one of the leading medicinal natural products. The first bulk and regular supplies were shipped to Europe from China, where it had been in use for some centuries and where it is known as Ma Huang, but the quality of the shipments were not altogether satisfactory and consumers sought an alternative source. In due course shipments were made from Spain, and the quality of the herb was an *improvement on the Chinese commodity. The cost of the raw* material was by this time economical and supplies were abundant, which allowed for considerable reductions in the sale-prices of the manufactured ephedrine products. The number of manufacturers of ephedrine increased and sale-prices became keenly competitive. Continental manufacturers also sought for business in this market. About twelve months ago the shipment of ephedra from Spain was disorganised and now seems to have ceased for the time being. Consumers have had to fall back on the Chinese product, but according to reports, there are not likely to be many more shipments from that source until the Sino-Japanese dispute is settled. The main source of supply in China is Tientsin, and it is in this district that the disturbance is centred. Dealers in London had long ago ceased to hold stocks owing to the fact that the chief consumers bought direct and, in any case, the price was far too low to allow for the expense of holding stocks. Consequently, there is probably not a single ton of ephedra on the London market. The last quotation from China for the herb was 19s. per cwt. *c.i.f.* in bulk quantities. The main consumers may or may not have good supplies on hand, but the outlook for further arrivals from Spain or China is not at the moment hopeful. Unless there is a renewal of supplies from one or other of the sources, there is bound to be a shortage of the raw material, and sale-prices for ephedrine may have further to be increased. It is interesting to learn that efforts are being made to develop a source of supply of ephedra in India, but, so far, it is stated, the quantities available have been unimportant. From another source we learn that limited supplies of Indian were offered here over twelve months ago, but, with Spanish and Chinese available, no interest was shown by consumers.—(*The Chemist and Druggist*, July 31, 1937, page 123).

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for August, 1937:

IMPORTS

ARTICLES	MONTH OF AUGUST					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	31	23	..	4,586	4,248
French Indo-China ..	390	40	141	45,687	5,622	14,953
Burma ..	..	..	11,379	..	..	14,50,475
Other countries ..	..	466	1,146	..	56,320	1,39,443
Total ..	390	537	12,689	45,687	66,528	16,09,119
Other than Teak—						
Softwoods ..	662	3,283	1,749	37,112	2,02,919	1,34,140
Matchwoods ..	..	877	566	..	45,595	37,984
Unspecified (value) ..	..	..	..	1,27,031	28,112	91,180
Firewood ..	29	38	49	435	578	735
Sandalwood ..	20	7	..	6,295	1,722	..
Total value of Wood and Timber ..	..	..	..	1,70,873	2,78,926	2,64,039
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Sleepers of Wood ..	..	..	157	..	..	24,678
Plywood ..	..	191	515	..	43,601	1,06,299
Other manufactures of wood (value) ..	..	..	..	1,70,294	1,02,295	1,62,257
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	1,70,294	1,45,896	2,93,234
Other Products of Wood and *Timber*—						
Wood pulp (cwt.) ..	26,414	17,891	9,006	1,69,217	1,18,877	62,086

EXPORTS

ARTICLES	MONTH OF AUGUST					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	2,273	3,904	35	4,18,366	7,88,571	4.600
" Germany ..	462	393	..	1,10,880	91,537	..
" Iraq ..	60	89	15	10,897	15,297	4,808
" Ceylon ..	77	98	1	8,508	11,496	100
" Union of South Africa ..	299	387	..	48,072	68,283	..
" Portuguese East Africa ..	10	59	..	2,150	9,880	..
" United States of America ..	20	..	..	4,496	..	..
" Other countries ..	404	449	56	79,146	93,669	17,530
Total ..	3,605	5,379	107	6,82,515	10,78,733	27,038
Teak keys (tons) ..	312	400	..	46,752	56,150	..
Hardwoods other than teak ..	..	235	..	..	23,914	..
Unspecified (value) ..	..	..	..	51,219	64,827	23,077
Total ..	312	625	..	97,971	1,44,891	23,077
Sandalwood—						
To United Kingdom ..	..	1	54	600	1,000	54,000
" Japan ..	..	..	7	..	..	6,800
" United States of America ..	15	72	1	16,060	99,048	800
" Other countries ..	17	20	22	22,103	23,409	20,145
Total ..	32	93	84	38,763	1,23,457	81,745
Total value of Wood and Timber ..	..	..	..	8,19,249	13,47,081	1,31,860
Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	6,231	2,614	25,229
Other Products of Wood and Timber ..	No data			No data		

INDIAN FORESTER

DECEMBER, 1937.

ACCOUNTS OF HIS EXCELLENCY THE GOVERNOR OF BOMBAY'S SHOOTS IN KANARA DISTRICT DURING THE YEARS 1936 AND 1937.

1936

Yellapur Camp lasted from 9th to 17th May 1936.

Their Excellencies Lord and Lady Brabourne arrived at Yellapur, having motored from Alnavar, at 10 a.m. on the 9th, and were accompanied by Mr. Bristow, Lt.-Colonel Toogood, Major and Mrs. Opie, Captain Walker and Mr. Yates.

9th May—Tatagar.—One tiger (8 feet 10¾ inches). Almost immediately on the arrival of His Excellency's party in camp at about 11 a.m. news of two kills was brought in and two consecutive beats were arranged. The first beat, which lasted from about 1 p.m. to 3-30 p.m., contained no tiger, but two bison, a large cheetal stag and a mouse-deer were seen. Immediately the first beat was over the party set off in cars for Tatagar jungle. Towards the end of the beat the tiger appeared in front of His Excellency's machan walking slowly. His Excellency shot him through the head at about twenty yards range.

10th May—Marikan (Magod).—One tigress (8 feet 9 inches). This was a long beat in thick jungle and was extremely hot for the guns as the machans were in the sun. The tigress walked out opposite His Excellency's machan towards the end of the beat. His Excellency shot her through the brain when she was about twenty yards from him. Besides the tigress a small cheetal and a mouse-deer were seen. Major Opie shot at the mouse-deer but did not hit it. The tigress was found to be carrying five well developed cubs which would have been born about a fortnight later.

Tatwal (Block 30).—One bear (6 feet 6 inches). Toogood shot this bear while out on an early morning walk.

A

11th May—Tatwal (Block 30).—One bison—height 18 hands ; horn span 38½ inches. His Excellency shot this bison when walking round in the evening with Mr. Hiley. His Excellency's first shot knocked it down. Hiley gave it a second shot while on the ground and it got up again and walked away. His Excellency gave it another shot as it went and it fell down, dying, after going about twenty yards.

Angod Jungle.—One male elephant (5 feet 9 inches) ; one cow elephant (7 feet 9 inches). Bristow went out with Butterworth (Mr. Hiley's step-son) after elephant in the morning. They found a herd and Bristow shot a small tusker. The rest of the herd ran away with the exception of one cow which looked menacing. For safety's sake Butterworth shot her.

Kotikeri.—One male pig—height 2 feet 10 inches. Shot on the way back to camp in the evening by Major Opie.

13th May—Kotikeri.—Two bison—horn span 30¼ inches and 33¾ inches. Faure Walker shot the first bison when out walking in the early morning. He took a long shot in the dark which was only excused by inexperience. The shikari was positive the bison was not hit and he galloped away apparently completely untouched. However the bison was found dead the following morning within three hundred yards of where he was last seen with two bullets in the shoulder.

The second bison was shot the same evening while out looking for the first.

14th May—Kannegiri.—One bison—horn span 30 inches. Toogood shot this bison in a young teak plantation when he and Faure Walker were out in the early morning. Toogood wounded the bison which entailed a follow up through thick bamboo jungle. As he was preparing to charge Toogood finished him off.

15th May—Baminya.—One tigress (8 feet 5 inches). News of kills at Baminya and Wadi Hukli came in simultaneously and His Excellency decided that the party should split, His Excellency, Bristow and Opie going to Wadi Hukli, and Toogood, Faure Walker and Yates going to Baminya. Wadi Hukli proved blank but Baminya held a tigress. She trotted past Faure Walker's machan who shot

her through the shoulder at about 25 yards range. This was towards the end of the beat.

16th May—Siddilgundi.—One tiger (9 feet 3 inches). This tiger killed in an unbeatable jungle so Yates sat up over the kill. He shot him at 8-25 p.m.

Hollagadde (*Sirsi Road*).—One mouse-deer and one porcupine. Shot at night with a ·500 rifle by Major Opie.

17th May—Kannegiri.—One tiger (9 feet). This beat was the result of a natural kill and took place on the way to the station. A great deal of game was seen—a herd of bison, pig, cheetal, sambhar, a mouse-deer, and three tigers, two of which broke back. The third tiger trotted up to Faure Walker whose machan was to one side behind the stops. The tiger was turned towards His Excellency and trotted through a thick patch of cover in front of him. His Excellency fired hitting it through the jaw and knocked it over. It remained down for half a minute where His Excellency could not see it. It got up and galloped off to the gun's left where it attacked a stop in a small tree and tore his dhoti off. It moved off and remained still for several minutes. It roared and suddenly appeared to Faure Walker behind his machan galloping all out down the side of a nullah. Faure Walker turned round and shot it dead through the shoulder.

Total bag.—5 tiger, 4 bison, 2 elephants, 1 bear, 1 pig, 1 mouse-deer, 1 porcupine.

1937

The Camp at Yellapur lasted from the 15th to 23rd May 1937.

Their Excellencies Lord and Lady Brabourne arrived at Yellapur, having motored from Dharwar, at 7 p.m. on the 15th, and the other members of the Camp consisted of Mr. Bristow, Lt.-Colonel Toogood, Mrs. Opie, Mr. Peter Opie and Mr. Yates.

16th May—Kotikeri.—Yates shot a bison (35 inches) which, after being hit, charged at, but missed, him.

Madanguli.—His Excellency shot a tiger (9 feet 1 inch) in good condition, which tried to break out on both sides of the beat.

Siddalgundi.—Toogood fired at a panther over a kill, but had to leave it as it disappeared into thick jungle and darkness prevented its being followed up. On the following morning the panther (7 feet) was found at a spot 150 yards from where it had been shot.

17th May—Hattigadda.—His Excellency shot a heavy tiger (9 feet 3 inches) after a long wait, due to the country being new and the beat a long one. The villagers were delighted at the killing of this tiger which had caused considerable loss amongst their cattle for some years.

19th May—Alvigadda.—This beat was in thick jungle, with the machans placed in a row in a clearing. After a longish beat a tiger came down the hill to His Excellency's left at the gallop, turning left-handed along the open patch making for thick jungle to His Excellency's front and right. His Excellency shot him when he was going all out. The tiger disappeared into thick jungle, and it was feared at first that it was only wounded, but it was found subsequently dead.

20th May—Siddalgundi.—Toogood set out very early, and at 5-30 a.m. saw a bison (30 inches) which he shot as it charged past him. Toogood continued his walk through the jungle, and at 7-35 shot a tiger (9 feet 3 inches). He had just reloaded when a tigress (8 feet 7 inches) appeared and stood looking at her mate, who was still kicking about 10 yards away. Toogood shot the tigress dead and then put a second shot into the tiger. A young bison then came up and sniffed at the corpses and only moved off after Toogood and the shikari had clapped their hands and shouted at it.

Alligaddi.—This was a lucky day for Toogood. A beat was held in the afternoon. A tigress came out near his machan, and he shot it as it was going to spring across an open patch. Length 8 feet 6 inches.

Tatwal.—Opie got up into his machan at 4-30 p.m. At 6-30 p.m. he heard something moving about, and at 6-55 a panther appeared and leapt on to the kill, which was a live goat, and killed it. The light was beginning to fade, so Opie shot the panther which could not be followed up, owing to darkness, but was found on the following morning. Length 6 feet 8 inches. The bullet was found to have

been diverted by the front shoulder blade and to have passed down through the entire length of the body, being stopped by the skin in the hind quarters after breaking a second leg.

21st May—Kansirda.—This beat was in open country. Three machans were placed. A tigress crossed a nullah and came across Bristow's left. He shot at her, after which she galloped on, crossed another nullah, returned towards the beat and was eventually found dead in the first nullah. Length 8 feet 2½ inches.

22nd May—Balgimane.—This was an evening beat. A tiger was heard moving about for a long time in front of the machans at some distance; their Excellencies catching glimpses of him every now and again, but never getting a good target. Finally he came out on the left of the beat near Toogood's machan, and was shot as he was trying to make his escape on the left of the guns. Length 8 feet 10 inches.

23rd May—Wadehukli.—This was the final beat on the way home. A tiger was reported to be an old warrior, and it was anticipated that the beat would be a long one. He was heard moving about by the people in all four machans and finally came out on a path below His Excellency who shot him as he sprang across the path to get out of the beat. Length 8 feet 10 inches.

Total bag.—**6** tiger, 3 tigress, 2 panther, 2 bison.

THE FINANCIAL POSSIBILITIES OF PLANTATIONS

By D. J. Atkinson, I. F. S.

During recent years, there has appeared a regrettable number of loose statements, entirely unsubstantiated by any figures, as to the financial possibilities of plantations, so much so that it has been held that planting on the long rotation necessary to produce teak timber of a size and specification suitable for export is too speculative a policy to be justifiable on any grounds, ***and that it is certainly not justifiable on economic grounds,***

2. Though the writer is not here concerned with plantation teak for export, which would necessarily be of Class I quality, he begs leave to question the above pronouncement, which was certainly not based on any actual financial calculations. He proposes to show that even Class III plantations, if suitably sited, and worked on a correct rotation, can be very paying propositions, and he has no doubt at all that, *a fortiori*, Class I plantations, producing timber of export quality, could also be made equally attractive.

3. Attached with this note is a recent note on the finances of a particular case, the Kyetpyugan plantations of Insein division. Full details are given in that note, and it is unnecessary to particularize here further than to say that, on present-day costs and present-day incomes, a favourably situated plantation such as Kyetpyugan, even though of lowest quality, is a very sound financial investment—what other investment can be expected to produce 7 per cent. compound interest ? In point of fact, conditions are even more favourable than that note indicates, for the reason that, though costs of formation have been taken at the normal provincial figure of Rs. 25, they will in fact be practically *nil*, as there will be no difficulty at all in obtaining Shan cultivators to plant the annual coupe at no cost other than that of seed, and possibly remission of taxes.

Those to whom compound interest is anathema will probably be more interested in the following figures of actual incomes and costs from the year of first formation—1868—to date. Costs, it may be noted, include pay of staff and even construction and maintenance of the local Forest Rest House, though it is arguable that this latter is not a legitimate charge :

		Rs.
Expenditure from 1868 to 1936	..	1,72,005
Revenue ,, ,, ,, ,,	..	1,19,897
Present adverse balance	..	52,108

Revenue to date is, however, entirely derived from intermediate yields, no final yield whatever having yet accrued. If the 836 acres

of plantations, now almost all over 65 years old, were felled to-morrow, the estimated yield, on the conservative basis used in the attached note, would be Rs. 4,17,500, converting the present adverse balance of Rs. 50,000 into a profit of three and a half lakhs.

This is, of course, a crude method of assessing the financial position, as the times when major costs and major incomes occurred naturally differ, and have a very important bearing on the financial results—interest, in fact, must be applied, as has been done in the attached note, though the above statement may give the layman some idea of the possibilities.

4. The present note is, however, more concerned with the profound effect that choice of rotation has on the financial results, and particularly with this effect as applying to Class III plantations. The attached statement presents a financial yield table for Kyetpyugan for different rotations, in which yields are based on the number of stems per acre normal to Class III, and on prices detailed in Appendix B to the Kyetpyugan note.

Schlich defines the financial rotation as that which—

(*a*) gives the maximum soil rental, or

(*b*) yields the highest profit, or

(*c*) yields the maximum mean annual forest per cent.

The attached yield table has been prepared to show all three of these, column 11 indicating the profit per acre, column 14 the net rental per acre, and column 15 the mean annual forest per cent.

It will be seen that, on the price rates used, which have been the subject of much consideration, discussion with an experienced revenue assistant, and comparison with past prices actually realized, all three methods place the financial rotation for these plantations as lying between 30 and 40 years. Column 16 of the table, which shows the Indicating per cent for the various periods gives another check. So

long as the Indicating per cent is above the normal rate of interest, $2\frac{1}{2}$ *per cent., the plantation is not financially ripe—when it falls below* this normal rate the stock is over-ripe, and though no actual loss may yet have occurred, it is financially unsound to keep the stock on the ground, and the money realizable would be better invested elsewhere (or in another crop on the same ground). This column also shows the financial rotation to lie between 30 and 40.

5. In this particular case, where incomes so greatly exceed costs, and where practically all thinnings are saleable, it is certainly true that even if the rotation were extended to 70 years, the handsome return of 5·2 per cent would still be realized. Nevertheless, it is apparent that such a course would not be financially justifiable, when, as is here the case, two crops bearing 7·3 per cent can be taken off the ground in the same number of years as one crop bearing 5·2 per cent.

Schlich has shown that, owing to the uncertainties that must obtain in such calculations, it is normally preferable to keep somewhat above the actual financial rotation, and as in the present case there is a very slight fall in returns between 40 and 50 years, the latter could probably safely be adopted as the actual rotation on which this forest should be managed, without any undue sacrifice being involved.

6. To leave the particular case of Kyetpyugan, and to turn now to the more general question of the rotations applicable to the various quality classes. Given a knowledge of costs, and of prices obtainable for the various yields, a financial yield table can, of course, be prepared for any plantation, and the financial rotation thus calculated. The writer, however, with some diffidence puts forward the following as a much simpler method of arriving at the same result, or at least of indicating the age beyond which a given stock should *not* remain on the ground.

Schlich has shown, in his chapter on the Forest per cent, which is the indicator as to how the money invested is working at the

various periods of the wood's life, that this Indicating per cent is the adddition of—

the Volume Increment per cent,
the Quality Increment per cent,
and the Price Increment per cent.

If it can be shown that the quality and price value are likely to be constant, then it follows that the Money Increment per cent, or Forest per cent, is proportional to the Volume Increment per cent. It is suggested that over the comparatively short period of, say, 10 years covering any probable rotation, the Quality increment, *i.e.*, value per unit of volume, is likely to remain constant—to make this clearer by an example, a Class II tree aged 60, girth 4′ 5″, height 97′, volume 29·5 c. ft. is not likely to fetch less *per ton* than a tree aged 70, girth 4′ 9″, height 100′ and volume 36·75 c. ft. Similarly in the case of price increment, there is no reason for supposing that over the short period that matters prices generally are going to rise or fall, assuming, of course, that the area concerned is already fully accessible and discounting the possibility of a sudden slump. This being accepted it follows that the Forest per cent becomes directly proportional to the Volume Increment per cent.

Incidental to his recent paper on the Beehole Survey, the writer found it necessary to construct volume curves for the commonly accepted three quality classes of teak. They indicate that, as might be expected, the Volume Increment culminates at different ages in the three classes—in Class III it appears to culminate at about 50, in Class II at about 70, and in Class I not at all during the period covered by the curves, that is, it is still rising up to age 80.

If it is accepted that the curves, over the short periods at issue, equally well represent the progress of the Indicating per cent, then it follows that the culmination points of the three curves indicate the ages beyond which it is not financially sound to maintain the crops on the ground.

The sub-joined table indicates the Volume Increment per cents as taken from these curves,

VOLUME INCREMENT PER CENTS.

Age.	Quality Class I.		Quality Class II.		Quality Class III.	
	Volume.	Increment per cent.	Volume.	Increment per cent.	Volume.	Increment per cent.
10 ..	2·5	%	1·25	%	·5	%
		12·7		13·8		11·8
20 ..	8·4		4·55		2·55	
		7·0		7·7		8·0
30 ..	16·6		9·6		5·5	
		4·7		5·1		5·1
40 ..	26·2		15·8		9·0	
		3·7		3·7		3·5
50 ..	37·75		22·8		12·9	
		3·2		2·8		2·4
60 ..	51·8		29·95		16·25	
		3·1		2·2		1·6
70 ..	70·0		36·9		19·0	
		3·0		1·7		1·3
80 ..	94·75		43·9		21·5	

Assuming 2·5 per cent as being the rate at which money can be obtained for investment in forestry, it is apparent that the investment becomes no longer profitable between 50 and 60 years in the case of III quality, between 60 and 70 in the case of II quality, and is still profitable up to 80 in the case of I quality.

7. The writer suggests that this simple method, entirely independent of costs or incomes, or of abstruse calculations with compound interest, is applicable to any plantation (by interpolation on the curves), and indicates at a glance the crucial point beyond which a profit is minimised or a loss magnified.

Financial yield table for Kyetpyugan teak.

Length of rotation.	Net value of yields. Final.	Net value of yields. Intermediate.	Sum of intermediate yields with interest at 2½ per cent to date.	Total yield to date.	Cost of formation 25/- with interest to date.	Cost of intermittent expenses, interest to date.	6 — 7	Total yield less all costs other than annual 5—8.	Annual costs with interest to date.	Profit 9 — 10.	Value of $\frac{1{\cdot}025^r - 1}{{\cdot}025}$	Gross rental 9/12.	Net rental 13-1·25 annual costs.	Mean annual forest per cent.	Indicating per cent during each period of 10 years.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
															Per cent.
(15)	..	25													
(20)	218	40	28	246	40·9	2·9	44	202	31·9	170·1	25·544	7·9	6·65	5·5	
30	450	145	87	537	52·4	4·1	56	481	54·9	426·1	43·904	10·9	9·65	8·0	5·8
40	450	130	297	747	67·1	5·5	73	674	84·3	589·7	67·404	10·0	8·75	7·3	2·6
50	520	100	547	1067	85·9	7·3	93	974	121·8	852·1	97·484	9·9	8·65	7·3	1·9
60	500	30	828	1328	109·9	9·8	120	1208	170·0	1038·0	135·992	8·8	7·55	6·4	1·82
65	500	..	971	1471	124·5	11·4	136	1335	198·9	1136·1	159·12	8·4	7·15	5·9	1·78
70	460	..	1089	1549	140·8	12·8	154	1395	231·6	1163·4	185·284	7·5	6·25	5·2	1·2

A NOTE ON THE FINANCES OF THE KYETPYUGAN TEAK PLANTATIONS

BY D. J. ATKINSON, I. F. S.

These plantations form a compact block of 836 acres, constituting the Reserve of the same name, and lying on the main Rangoon-Prome Road at a distance of about 25 miles from Rangoon.

Much the greater portion of the area, 683 acres, was planted between 1868 and 1871, by direct labour as opposed to *taungya*, and cost the large sum of Rs. 59,530 or Rs. 87·1 per acre.

The remaining 153 acres were planted by the *taungya* system, between 1884 and 1891 (except for 10 acres formed in 1901), and cost considerably less, Rs. 42·7 per acre.

2. The plantations are of poor quality, falling for the most part into quality class III or lower, and the timber is, on the whole, small, crooked and fluted. Nevertheless, their very favourable situation makes these plantations extremely valuable and everything is saleable, including 7′ branch lengths, as fence posts.

3. The plantations, or the greater portion of them, are now 65 to 68 years old, and as it seemed likely that by this age plantations of this quality should be at, or approaching, maturity, it was decided to make small experimental clear fellings in two of the oldest plantations, with a view to assessing the probable final yield per acre, and also as an experiment in regeneration for the second rotation.

Consequently two small plots were chosen, one of 5·3 acres, in Plantation No. 2 of 1869, as representing the most inferior quality in the plantations, and the other, of 3·2 acres in Plantation No. 5 of 1871, as representing a good average of the better quality stock.

Both plots were felled and logged departmentally between January and March 1936, and all produce other than fuel extracted to Satthwadaw Depot, on the edge of the Reserve, where it now lies. Teak fuel, and the yield from timbers other than teak also practically entirely fuel, were sold *in situ* for slightly more than their ordinary royalty value. Detailed measurements of the outturn of each tree were taken, and are being sent to the Silviculturist,

4. Appendix A attached hereto gives details of the total outturn from each plot, and estimates of the value at depot of this outturn. These estimates are based on actual prices received annually, and are considered to be, if anything, on the conservative side—in some cases the estimates are themselves actuals, as the produce, or some of it, has been already sold.

The Appendix shows that the net final yield per acre is in the one case Rs. 151·6, and in the other Rs. 550·6. It should be noted that in the former case at least a quarter of the acreage felled was ineffective, as it carried no teak at all, being low-lying and waterlogged, and that, therefore, even the worst quality Kyetpyugan teak is likely to produce as a final yield appreciably more than Rs. 150 per acre.

5. It is not at the moment possible to determine with exactitude the profit or loss on the *existing* plantations, as records of past expenditure and receipts, if available at all, will be hidden in old journals, and forthcoming only after considerable search. It can hardly be expected, however, that with the very high initial charge of Rs. 87·1 per acre the capital invested can have borne any appreciable interest, even if an actual loss has been avoided.

It is, however, of greater value to compare present yields with the *present* costs of reforming these plantations, which do not, of course, approach those of the last rotation.

Taking costs of formation at Rs. 25 per acre, the figure usually accepted as normal for the present day, interest at $2\frac{1}{2}$ per cent and incomes at the present rates, Appendix B attempts a theoretical calculation of the financial possibilities of a modern plantation, similar in quality and situation to those of Kyetpyugan.

The results from this calculation, which, it is claimed, has taken account of all reasonable costs, including overheads, are extremely gratifying. They show that (under the admittedly favourable conditions of Kyetpyugan) a plantation of average quality Class III may be expected to show a profit per acre of Rs. 852·1 on a 50 years rotation, and a profit of Rs. 1,102·7 on a 65 years rotation—or, put in another way, perhaps easier to follow, that the mean annual

interest on the capital invested has been 7·3 per cent on the shorter rotation—5·9 per cent on the longer.

6. Though it is admitted that few other plantations in Burma are as favourably situated as those under consideration, unless, it may be, the Magayi plantations, also in Insein division, it should be appreciated that the days of dotting small isolated plantations about the backwoods of the Pegu Yomas and worse, are gone, and that all modern plantations are sited after careful consideration of lines of extraction and future markets. It seems probable, therefore, from the figures given above, that the majority of even Class III plantations, as at present formed, are financially sound propositions, provided the rotation is not allowed to become too long.

This is always a matter of great importance, but particularly so where plantations of inferior quality are concerned, in which the mean annual increment culminates at an early date, the stock thereafter more or less stagnating. The writer is at present preparing a note on this general question—here it is sufficient to mention that in the present case it can be shown that, though the net profit per acre is, of course, greater on the longer rotation of 65 years (Rs. 1,102 compared with Rs. 852), it is not financially sound to maintain the stock on the ground for this further 15 years, as the current forest per cent, or "Indicating per cent," for the period is only 1·78 per cent, well below the normal per cent of 2·5 with which the calculations have been made.

7. It is suggested that there can be few other activities of Government which can claim to produce 7·3 per cent compound interest on the capital invested, and that the present attempt, the first in Burma so far as the writer is aware to assess the financial position of any particular plantation, provides a sufficient answer to the pessimists who have maintained that no plantations are likely to be other than financial burdens.

[The criticism of these notes by Mr. B. E. Smythies, I.F.S., and Mr. Atkinson's reply thereto, which were received along with these notes, will appear in the next issue of the *Indian Forester*.—ED.]

APPENDIX A

Plantation No. 5 *of* 1871—(away from road).

Age.—65 years.

Area.—3·19 acres (of plot).

Number of trees.—228, but 6 felled and cut up by Silvic and not included in volume figures.

		c.ft.
Volume.—Total volume of commercial bole	..	4,590·6
Volume of "smallwood" other than fuel, *i.e.*, fenceposts, etc.	..	349·2
Volume of fuel, 2,210 stacked	..	1,458·6

Average outturn of timber (as distinct from smallwood) per tree—

$$\frac{4{,}590 \cdot 6}{222} = 20 \cdot 7 \text{ c.ft.}$$

For assessment of quality it is necessary to consider only the dominants. Trees were not classified at time of felling, but it is possible to pick out the dominants from the table by total height. The tallest tree in the coupe was 97′—all trees 85′ and over, therefore, 47 in number, have been accepted as dominants and their volume alone is considered in assessment of quality. The average volume of stemwood timber in these 47 trees, to approximately 8″ top diameter, is 35·0 c.ft., which places them at a fraction over Class II, the volume of which at 65 years should be 33·2 c.ft. It is apparent, however, that even over the 3 acres of the coupe the quality has varied considerably, the above being the best—probably over the plantation as a whole the quality lies between Class II and III.

Outturn and Value.

			Rs.
Teak	292 logs, 4,003·1 c.ft. @ 20/- per ton	..	1,601·2
	29 short logs, 209·6″ (sample trees) @ 22/- per ton	..	92·2
	126 houseposts, 633·0 c.ft. @ 10/- per ton		126·6
	208 fenceposts, 303·7 c.ft. @ -/4/- each	..	52·0
	Fuel, 2,210 (stacked) @ 6/4/- %	..	13·8
Others	Fuel, 1,734 (stacked) @ 6/4/- %	..	10·8
	Premium	..	28·0
		..	38·8
Total revenue off 3·19 acres—Teak		..	1,885·8
Others		..	38·8
			1,924·6

		Rs.	a.	p.
Expenses.—Felling and extraction	.. ..	168	3	0
Measuring	... ..	45	8	0
		213	11	0

Cost of measuring should not, however, be debited, as this is quite abnormal, and was incurred only to obtain accurate figures of outturn for financial calculations.

	Rs.
The net yield per 3·19 acres therefore = ..	1,924·6
	—168·2
	1,756·4
Therefore net yield per acre $= \frac{1,756 \cdot 4}{3 \cdot 19}$ ..	550·6

Assuming cost of formation to be normally 25/- per acre, rate of interest $2\frac{1}{2}$ per cent, and that intermediate charges are exactly offset by intermediate yields, at 65 years cost has amounted to—

$$C_{65} = C_o \times 1{\cdot}0p^{65}$$
$$= 25 \times 1{\cdot}025^{65}$$
$$= 25 \times 4{\cdot}978$$
$$= 124{\cdot}45$$

at 87/- per acre.

$$\therefore C_{65} = 87 \times 1{\cdot}025^{65}$$
$$= 87 \times 4{\cdot}978$$
$$= 433{\cdot}1/\text{-}$$

Final cost = 124·45
,, yield = 550·6

Profit = Rs. 426·15 per acre.

Alternatively, initial outlay of 25/- has resulted in a final yield at age 65 of 550/-.

Therefore per cent = a fraction below 5 per cent.

Plantation 2 *of* 1869 (*near road*).

Age.—67 years.

Area.—5·3 acres (of plot).

Numbers of trees.—297 (serial numbers), but two produced no outturn, one being a stump and the other hollow. Also six trees felled and cut up by Silvic, and not included in volume figures. Therefore 289.

		c.ft.
Volume.—Total volume of commercial bole (timber)	..	2,610·7
Volume of "small wood."		
Fenceposts taken from branch pieces, etc.	..	53·2
Fuel (stacked 2,280)	.. ..	1,504·8

Average outturn of timber per tree—$\frac{2610 \cdot 7}{289} = 9$ c.ft.

Again, the quality class has been assessed only from the dominants, which in this coupe are considered to be all trees over 70′, 35 in number. Their average stem wood volume amounts to 18·02 c.ft. which is almost exactly that of III quality (18·2 c.ft. at 67 years). The plantation, as a whole, however, or that portion of it of which this coupe is representative, is considerably below Class III.

Outturn and Value.

			Rs.
Teak	218 logs, 1,812·3 c.ft. at 17/- per ton	..	616·2
	23 short logs (samples), 85·3 c.ft. @ 20/- per ton		34·1
	145 houseposts, 524·5 c.ft. @ 10/- per ton	..	104·9
	191 fenceposts, 286·5 c.ft. @ -/4/- each	..	47·7
	Fuel, 2,280 stacked @ 6/4 % c.ft.	..	14·3
			817·2

			Rs.
Others	4 logs, 94 @ 3/-	..	5·6
	Fuel, 9,786 @ 6/4/- %	..	61·2
	Premium	..	29·6
			94·7

		Rs.
Total revenue off 5·3 acres—Teak	..	817·2
Others	..	94·7
		911·9

		Rs.	a.	p.
Expenses.—Felling and extraction	.. ..	108	11	0
Measuring	.. ..	54	4	0
		162	15	0

Cost of measuring, however, is abnormal and should not be debited.

		Rs.
Net yield off 5·3 acres	..	911·9
		—108·7
		803·2

Therefore net yield per acre $=\frac{803 \cdot 2}{5 \cdot 3}=$ Rs. 151·6

C_{65} (c. f. Plantation No. 5) $= 124 \cdot 45$

$\therefore C_{67} = 124 \cdot 45 \times 1 \cdot 0506 = 130 \cdot 7$

Final cost $= 130 \cdot 7$

,, yield $151 \cdot 6$

Profit $= 20 \cdot 9$

Or, initial outlay of 25/- has resulted in a yield of 151·6 at age 67.

Therefore per cent $= 2\frac{1}{2}$.

Had, however, the final yield been taken 17 years ago at age 50, during which time this very poor plantation has put on practically no increment, the final yield may be taken as the present one, but the costs would have amounted only to $25 \times 1 \cdot 025^{50} =$ Rs. 85·93, giving a profit of Rs. 65·7 per annum or a per cent of about $3\frac{3}{4}$.

APPENDIX B.

Theoretical calculation of probable financial position of a III *quality plantation* on a rotation of 50 years.

Interest, $2\frac{1}{2}$ per cent.

Expenses—

A.—*Intermittent*.

(1) Formation (all expenses in first 5 years).

(2) Thinning (unremunerative) at 5 and 10 years.

(3) Creeper-cutting, every 10 years.

(4) Maintenance of paths, boards, etc., say every 10 years.

B.—*Annual*.

(1) Fire-protection.

(2) Staff.

B. (1) *Fire-protection* .. on past actuals for Kyetpyugan averages -/3/- per acre per annum. Take -/4/- average for province.

			Rs.
(2) Staff	.. Say 2 Foresters at 30/-	.. =	720
	1/20th Range Officer's pay at 200/- ..	.. =	120
			840

on 836 acres.

= 1/- per acre.

Therefore annual costs = -/4/- + 1/- = Rs. 1/4 per acre

$$E_{50}=\frac{e\,(1{\cdot}0p^{n}-1)}{{\cdot}0p^{n}} \qquad \text{(For. IV)}$$

$$=\frac{20\,(1{\cdot}025^{50}-1)}{16\times{\cdot}025}=\frac{20\times 20{\cdot}3623}{16}\times 3{\cdot}4371$$

= Rs. 121·8 per acre.

A (1) *Formation.*—25/- per acre.

$E_{50}=E_{0}\times 1{\cdot}0p^{n}=25\times 3{\cdot}4371=$ Rs. 85·9 per acre.

(2) *Thinning* at 5 years—say Rs. ½ per acre.

$$E_{50}=E_{5}\times 1{\cdot}0p^{n-5}=\frac{18\times 1{\cdot}025^{45}}{16}=\frac{18\times 3{\cdot}0379}{16}$$

=Rs. 3/4 per acre.

Thinning at 10 years—say -/12/- per acre.

$$E_{50}=E_{10}\times 1{\cdot}0p^{n-10}=\frac{12\times 1{\cdot}025^{40}}{16}$$

$$=\frac{3\times 2{\cdot}6851}{4}=\text{Rs. 2 per acre.}$$

Therefore total under thinning=Rs. 5·4 per acre.

(3) *Creeper cutting*—say -/3/- per acre ⎫ every 10 years.
(4) Paths, boards, etc., say -/1/- per acre ⎭
-/4/- per acre

Rs.

at 10 *years.* $E_{50}=E_{10}\times 1{\cdot}0p^{n-10}=\frac{4\times 2{\cdot}6851}{16}=$ ·67

at 20 *years.* $E_{50} = E_{20} \times 1{\cdot}0p^{n-20} = \frac{4 \times 2{\cdot}0976}{16} =$ ·52

at 30 *years.* $E_{50} = E_{30} \times 1{\cdot}0p^{n-30} = \frac{4 \times 1{\cdot}6386}{16} =$ ·41

at 40 *years.* $E_{50} = E_{40} \times 1{\cdot}0p^{n-40} = \frac{4 \times 1{\cdot}2801}{16} =$ ·32

1·92

Total costs to end of rotation, therefore,

$=121{\cdot}8+85{\cdot}9+5{\cdot}4+1{\cdot}9$

=Rs. 215·0 per acre.

The same costs at 65 *years.*

B (1) & (2)—1/4 per acre.

$$E_{65} = \frac{20 \times 31{\cdot}96 \times 4{\cdot}98}{16} = 198{\cdot}9$$

A (1) —25/- per acre.

$$E_{65} = 25 \times 1{\cdot}025^{65} = 25 \times 4{\cdot}9780 \qquad = 124{\cdot}5$$

A (2) $E_{65} = \frac{18 \times 1{\cdot}025^{60}}{16} = \frac{9 \times 4{\cdot}3998}{8} = 4{\cdot}9$

(2) b $E_{65} = \frac{18 \times 1{\cdot}025^{55}}{16} = 9 \times 3{\cdot}8888 = 2{\cdot}9$

$$\left.\begin{matrix} 4{\cdot}9 \\ 2{\cdot}9 \end{matrix}\right\} = 7{\cdot}8$$

A (3 & 4) 10 years. $E_{65} = \frac{4 \times 3{\cdot}888}{16} =$ ·97

20 years. $= \frac{4 \times 3{\cdot}0379}{16} =$ ·76

30 years. $= \frac{2{\cdot}3732}{4} =$ ·59

40 years. $= \frac{1{\cdot}8539}{4} =$ ·46

50 years. $= \frac{1{\cdot}4483}{4} =$ ·36

60 years. $= \frac{1{\cdot}1314}{4} =$ ·28

3·42 = 3·4

334·6

Therefore, total costs to end of a rotation

of 65 years =Rs. 334·6

Incomes. *A.—Intermediate*

(1) Thinning at 15 years.

(2) ,, ,, 20 ,,

(3) ,, ,, 30 ,,

(4) ,, ,, 40 ,,

B.—*Final.* Yield at 50 years.

		Rs.
A (1) *Thinning at 15 years.*		
115 poles value -/4/- each	=	29
Less cost of thinning @ 2/- per acre.	=	2
Sold *in situ* net income say	..	25

$C_{50}=C_{15}\times1.0p^{n-15}$

$=25\times1{\cdot}025^{35}=25\times2{\cdot}3732=$Rs. 59·3

		Rs.
(2) *Thinning at 20 years.*		
65 poles value -/12/- each	=	49
Less cost of thinning @ 2/- p. a. ..	=	— 2
And cost of extraction to depot @ -/2/- each	=	— 8
Net income say ..		40

$C_{50}=40\times1{\cdot}02^{\,50-20}$

$=40\times2{\cdot}0976$ .. .. = 83·8

(3) *Thinning at 30 years.*		
75 poles value 2/8 each	=	187
Less cost of thinning @ 3/- p. a. ..	=	— 3
Less cost of extraction to depot @ -/8/- each	=	— 37
Net income say ..	=	145

$C_{50}=145\times1{\cdot}025^{\,50-30}$

$=145\times1{\cdot}6386$ .. .. = 237·6

(4) *Thinning at* 40 *years.*

45 trees value 4/- each ..	.. =	180
Less cost of thinning @ 2/- p. a.	.. =	— 2
Less cost of extraction @ 1/- each	.. =	— 45
Net income say	.. =	130

$C_{50}=130 \times 1{\cdot}025^{50-40}$

$=130 \times 1{\cdot}2801$ .. .. = 166·4

B.—*Final Yield at* 50 *years.*

105 trees, value 6/- each ..	.. =	630
Extraction @ 1/- each ..	.. =	— 105
Net yield say	.. =	520

Total revenue to end of rotation of 50 years therefore equals 59·3+83·8+237·6+166·4+520

=1067·1 per acre.

Total costs =215·0

Therefore Profit = Rs. 852·1 per acre.

The same incomes on a rotation of 65 years.— Rs.

A (1) $C_{65} = 25 \times 1{\cdot}025^{65-15}$ .. ..

$= 25 \times 3{\cdot}4371$ .. .. = 85·9

(2) $C_{65} = 40 \times 1{\cdot}025^{65-20}$ .. ..

$= 40 \times 3{\cdot}0379$ .. .. = 121·5

(3) $C_{65} = 145 \times 1{\cdot}025^{65-30}$ .. ..

$= 145 \times 2{\cdot}3732$ .. .. = 344·1

(4) $C_{65} = 130 \times 1{\cdot}025^{65-40}$ .. ..

$= 130 \times 1{\cdot}8539$ .. .. = 241·0

(5) *Thinning at* 50 *years.*

20 trees value 6/- each ..	.. =	120
Less cost of thinning @ 2/- p. a.	.. =	— 2
Less cost extraction @ 1/- each	.. =	— 20
Net income say	.. =	100

$C_{65} = 100 \times 1{\cdot}025^{65-50}$

$= 100 \times 1{\cdot}4483$ .. .. = 144·8

B. *Final Yield at 65 years.*

85 trees value 7/- each	..	=	595
Less cost of extraction @ 1/- each	..	=	— 85
Net yield say	..	=	500

Total revenue therefore equals 85·9+121·5+344·1+241·0 +144·8+500

= 1,437·3 p. a.

Total costs 334·6

Profit Rs. 1102·7 per acre

The above calculations indicate the profit per acre for a single rotation only, thus assuming that the land thereafter lies waste or is otherwise utilised. Correctly, the calculation should be made on the assumption that the land is again planted to a forest crop (as it certainly would be) and that incomes and expenses are operating for ever. For this calculation the formula to be used is as follows: (*Schlich*, p. 152 ; p. 136, Vth Ed.)

$$P = \frac{Y_r + T_a \times 1{\cdot}0p^{r-a} + \ldots + T_q \times 1{\cdot}0p^{r-q}}{1{\cdot}0p^{r}-1} - (S_c + E + I + C)$$

where Y_r=final yield, T_a & c=thinnings, E. I. & C = capitalized value of annual, intermittent, and formation expenses, S_c=cost value of soil, and p=normal rate of interest.

Inserting the correct figures,

$$P = \frac{1067}{2{,}4371} - \frac{20}{16 \times {\cdot}025} - \frac{86+7}{2{,}4371} - S_c$$

$$= \frac{974}{2{\cdot}4371} - 50 - S_c$$

$$= \text{Rs. } 349{\cdot}6 - S_c$$

As the land already belongs to Government, and in Burma would so belong even if not already under a forest crop, S_c=0, therefore the profit per acre=Rs. 350, which figure is, in fact, merely the

present value of a profit of Rs. 852 accruing every 50 years for ever.

$$\left\{ \text{Proof} —— C_o = \frac{R}{1{\cdot}0p^{n-1}} \quad \text{(Formula VIII)} \right.$$

$$\left. = \frac{852}{1{\cdot}025^{50} - 1} = \frac{852}{2{\cdot}4371} \qquad = 349{\cdot}6 \right\}$$

An alternative way of considering the matter, and possibly more intelligible, is to ascertain the rate of interest yielded by the capital invested, in other words, the Forest per cent. For this calculation, however, it is absolutely necessary to take a figure for S_c, *i.e.*, the cost value of the soil, as this is the capital invested, and without it the matter becomes a *reductio ad absurdum.*

Though it has already been pointed out that in Burma all land, until alienated, vests in the State, it might reasonably, perhaps, be assumed that the land in question, if not under a forest crop, would be under garden cultivation—it is not paddy land—at Rs. 3 per acre per annum. A theoretical cost value may, therefore, be arrived at as the present value of a perpetual rental of Rs. 3, which is Rs. 120. Taking this as the value of S_c, the mean annual forest per cent is obtained from the formula (*Schlich,* p. 161, p. 142, Vth Ed.)

$$\text{Mean pf} = \frac{\left\{ \dfrac{Yr + Ta \times 1.0p^{r-a} + \ldots + T^q \times 1{\cdot}0p^{r-q} - c \times 1.0p^r}{1.0p^r - 1} - E \right\} \times {\cdot}0p}{S_c} \times 100$$

$$\text{Mean pf} = \frac{\left\{ \dfrac{Yr + \Sigma Ta \times 1.0p^{r-a} - c \times 1{\cdot}0p^{r}}{1.0p^r - 1} - E \right\} \times {\cdot}0p}{S_c} \times 100$$

Inserting the correct figures as before :

$$\text{Mean pf} = \left\{ \frac{\dfrac{(1067 - (86+7)}{2{\cdot}4371} - 50}{120} \right\} \begin{matrix} \times \ 025 \\ \times 100 \end{matrix}$$

$$= \frac{349{\cdot}6 \times {\cdot}025}{120} \times 100$$

$$= {\cdot}0728 \times 100$$

$$= 7{\cdot}3 \text{ per cent.}$$

EXPLOITATION OF THE ANDAMAN FORESTS

By B. S. Chengapa, P.F.S.

Part II.

(*Continued from pp. 753-768 of the Indian Forester for November 1937.*)

Past failures and their causes.—While doing mapping and enumeration in 1929 in Bomlungta a rare opportunity of studying thoroughly the Bomlungta tramline presented itself. It was then the writer's conviction that Mr. Pearce's remarks on Skidder " to try to operate without expert supervision would be courting trouble, if not failure, and might retard the whole progress of Andaman forest exploitation by damning mechanical extraction as unsuccessful, and preventing its manifold advantages being gained in the future. There are so many little things that the novice would overlook, but which make all the difference in outturn and costs, " were more applicable to this tramline than to anything else in the Andamans. It cannot be an easy matter to make a tramline at Rs. 30,000 to Rs. 50,000 per mile and a Skidder at Rs. 75,000 to Rs. 1,00,000 pay when the merchantable timber is rarely more than 5-6 tons per acre. It, however, seemed possible that with a careful alignment and strict economy in construction a much cheaper tramline could be built, and that combined with efficient drag-paths such as those introduced by Mr. Tireman in Makut, Coorg, seemed the best possible solution.

From a cursory inspection of the Andaman Islands it would appear that these islands are extremely hilly and therefore a tramline is an extremely costly affair. But a closer examination reveals the fact that the banks of the streams and creeks and also coastal areas are nearly always easy and permit construction of cheap tramlines. Therefore, with main lines along main streams and spur or branch lines along feeders combined with efficient graded drag-paths up to and shoots down the hills, it gives a gradient all in favour of the load, making extraction of even the biggest log 5-6 tons—actual weight about 7-8 tons—extremely easy and simple. But the introduction of this method was not easy especially with the memories of the recent failures.

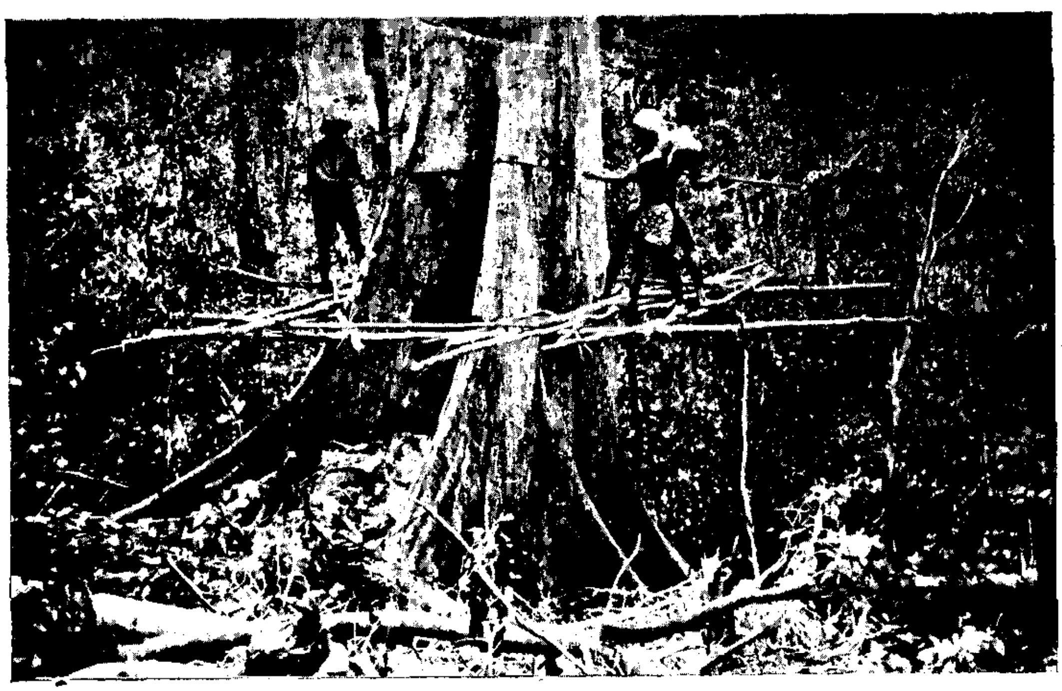
In 1931 the writer was placed in charge of all Middle Andaman extraction. Another opportunity to study the problem of extraction was thus given to the author. There were then eight Burman petty contractors who had previously worked in departmental extraction camps as jawabdars, analogous to foresters and forest guards in India. These men, with two elephants and four buffaloes each, were taking out in all about 1,500 tons of timber per month. The buffaloes soon became unpopular and were abandoned and the elephants became the main dragging power. Their method was simple. After felling and logging the logs were dragged to tide water, the only work done to help dragging being a clearing of undergrowth and small trees and throwing a few small short-length poles across and under the logs as they moved along. They had not seen anything better.

The writer tried to introduce graded drag-paths and shoots but as these needed investment of capital, the contractors refused to listen. They, however, could not continue long in Middle Andaman and wanted to shift to South Andaman or North Andaman where easy areas were still available. The writer then traced an alignment in Long Island in 1933 and with two miles of tramline at Rs. 1,500 a mile using Bomlungta abandoned rails, hoped to extract all timber—15,000 tons—that was locked up in this island. He therefore suggested that the contractors should accept Rs. 4 per ton of timber obtained in Long Island, Re. 1 being debited towards cost of construction of tramline and its maintenance, etc. The contractors, however, refused to accept these terms.

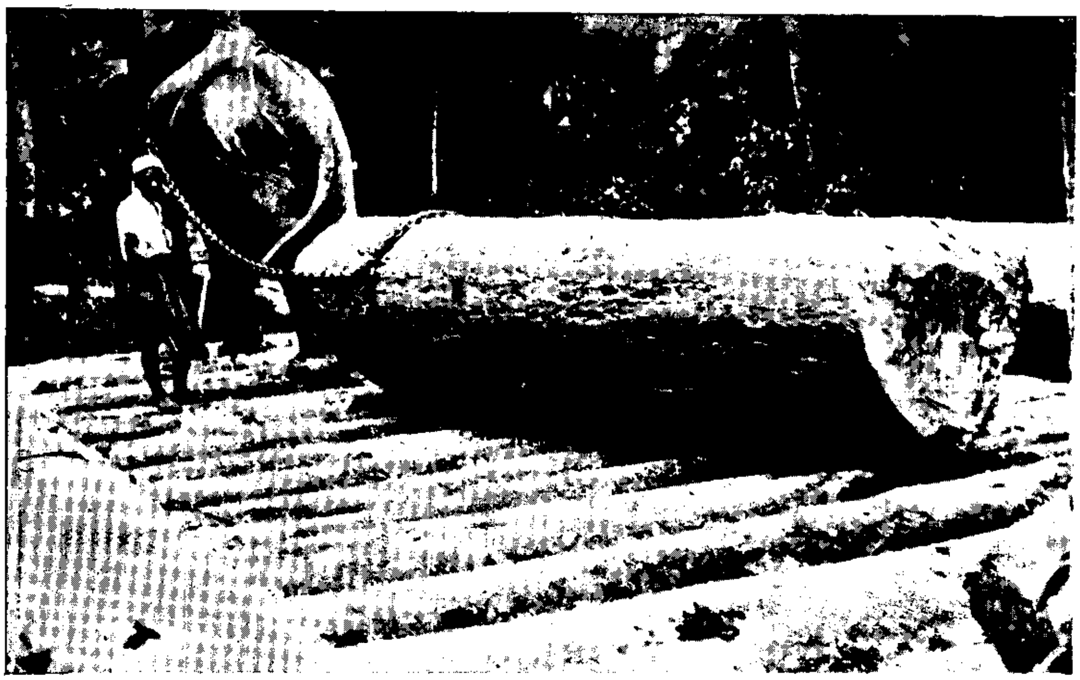
In the meanwhile four of the contractors were removed for bad work. In their places a departmental camp was organised by the writer in Charalungta and later in Lurutaung, places already worked by the department and also by the contractors in the past and had been abandoned as too costly to work further. Except for a small quantity of timber near the creeks, the dragging distance was more than a mile.

The organisation of departmental extraction camps was very much the same as that of many years ago. Sixty to seventy coolies with four to five jawabdars and eight to ten elephants under one

EXTRACTION CAMP, LURUTUNG.
THE SHED IN THE FOREGROUND IS THAT OF THE RANGE OFFICER. THE FLOORS OF ALL SHEDS ARE RAISED OFF THE GROUND



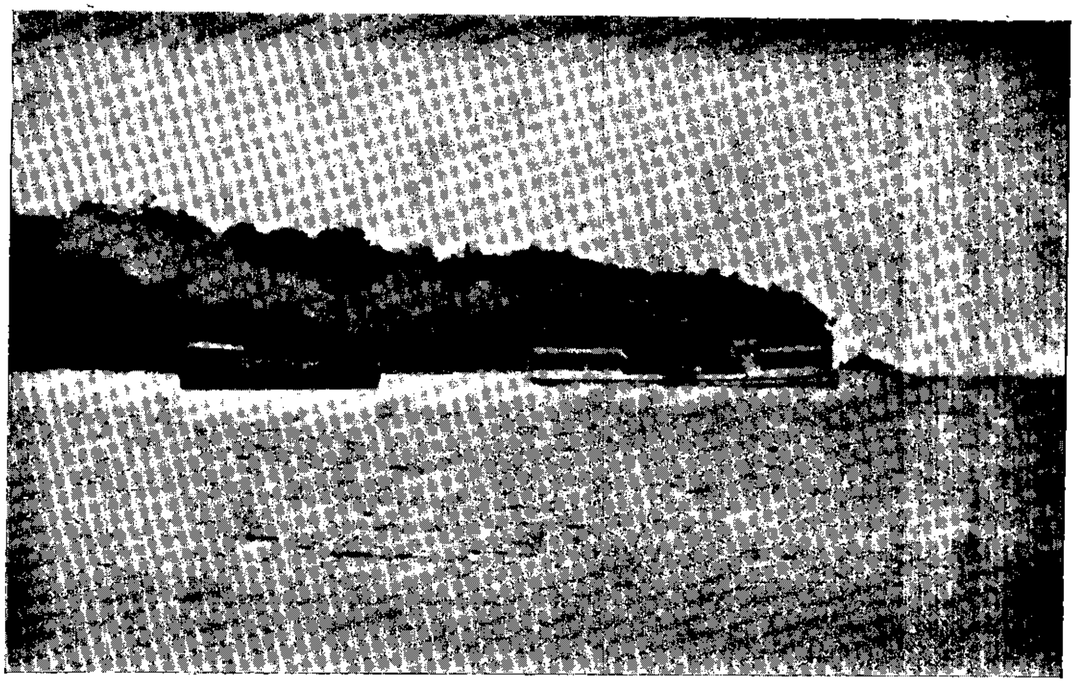
SAW AND AXE ARE USED FOR FELLING TREES. WEDGES ARE USED FOR HASTENING THE FALL.



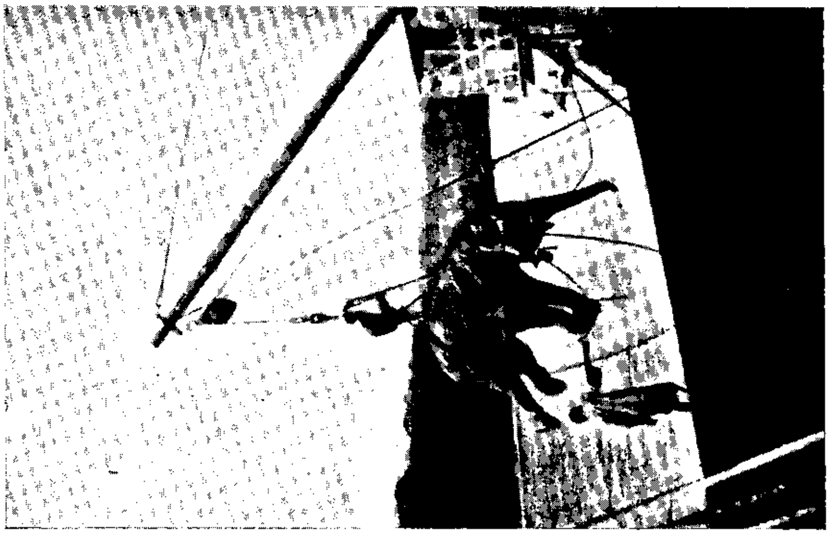
DRAGGING ON A PROPERLY CONSTRUCTED DRAG PATH. NO DRAG HOLE IS CUT: THE CHAIN IS FASTENED AROUND A NOTCH ABOUT 1" DEEP CUT AROUND THE CIRCUMFERENCE OF THE LOG. ONE END OF THE LOG IS SNIPED TO FACILITATE DRAGGING

A SUPERANNUATED ELEPHANT (HARIEL PRASAD) TRANSPORTS 25 TONS PER TRIP AND DOES TWO TRIPS OVER 2·3 MILES PER DAY

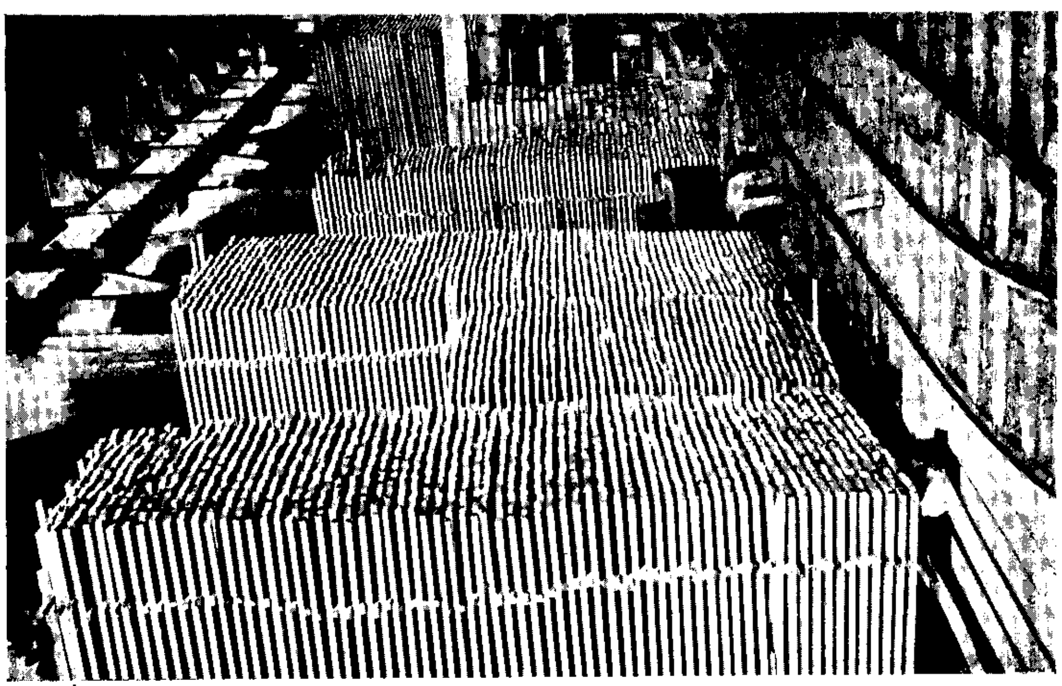
SMALL RAFTS ARE POLED DOWN AND ASSEMBLED AWAY FROM AWKWARD BENDS IN CREEKS



S. L. "SURMAI" WITH LOADED BARGE IN TOW JUST LEAVING RANGAT BAY FOR HIGH SEAS EN ROUTE TO PORT BLAIR



AN UNWILLING PASSENGER BEING TAKEN BY S. L. "DOUGLAS" FOR TRANSPORT TO ANOTHER ISLAND
Photo: E. L. P. Foster, I.F.S.



SAWN MATERIALS AT CHATHAM TIMBER YARD. DOUBLE RAILWAY TRACKS AND NUMEROUS SWITCHES AND CROSSINGS MAKE HANDLING EXTREMELY EASY. THESE MATERIALS ARE STACKED IN OPEN SHEDS WITH A ROOF OF CORRUGATED IRON SHEETS. IMPROVEMENTS WORKED OUT ENTIRELY BY MR. FLEWETT

forester (on Rs. 50-5-75 per month), usually addressed as range officer, constituted an extraction camp. The divisional forest officers were in charge of saw mills necessitating their presence always at headquarters and the Chief Forest Officer was also similarly tied down to headquarters to receive and to reply to telegraphic orders for timber from various Indian and foreign markets and could not find time to visit the extraction camps as frequently as they should. Far too much was therefore left to the subordinates in charge of the camps who were, and are still, in nearly all cases, untrained men and borne on the temporary establishment (F.A.A.R. 1927). Well aligned and constructed drag-paths and log shoots were therefore unknown. It was also the writer's conviction that the camp was too unwieldy for a forester to manage efficiently especially as supervision of their work by superior officers was extremely difficult and that very few places were capable of supporting 8—10 elephants for want of adequate fodder and water-supply. It had therefore been necessary to shift camps frequently resulting in enormous waste of time and energy with reduced output at increased cost. Cost of extraction was therefore rarely less than Rs. 5-11-6 per ton.

The writer therefore organised a camp of smaller unit, 4—6 elephants and 30—35 men, under a forester and started extraction in Charalungta and later in Lurutaung in Middle Andaman. Graded drag-paths 8 to 10 feet wide with short poles 8 to 10 feet long 5 to 6 inches diameter laid across at intervals of 2 to 3 feet were constructed before dragging operations started. From the very outset the cost of extraction, including the pay of the ranger (when the ranger was in charge), came down to Re. 1-12-0 per ton and eventually to Re. 1-4-0 per ton. The enormous saving that was effected by this simple reorganisation could be imagined when it is considered that the total output of timber in the Andamans is 40,000 to 45,000 tons per year. Mr. Flewett, a shrewd business man, at once terminated all contracts.

Present methods.—This reorganisation alone, however, was not sufficient to solve the serious problem of extraction as all coastal areas had by now been worked out. The writer therefore proposed

a tramline in Rangat Valley for tapping interior areas, made alignments for both main lines and spur lines and also for drag-paths and submitted a detailed scheme for the exploitation of this valley. He suggested the use of the abandoned rails from Bomlungta and pointed out that the cost of rail-road construction and rail-road transport would not be more than Re. 1-1-0 per ton (excluding charges on felling, yarding to rail, etc.). The cost of tramline construction with free imported labour was estimated to be about Rs. 2,000 per mile. Mr. Flewett, an Engineer himself, sanctioned the scheme and the work was taken in hand in November 1934 with free labour imported from Ranchi. These men were paid Rs. 15 and later Rs. 16—20 per month. (They paid their own passage.)

Though this work was absolutely new and the men from the executive staff down to the cooly had to be trained, the tramline 2½ feet gauge was put through at an average cost of Rs. 1,800 per mile and the first load of timber was transported in February 1935.

The main feature of the line was that it was graded downhill the whole way from stump site to tidal water. Costly culverts and bridges were avoided. In their places hollow *padauk* logs were used as culverts and simple and rough wooden pile bridges with wooden stringers thrown across were built. Round branch pieces of trees were utilized as sleepers and the whole length was corduroyed with poles 5—6 feet long and 3 to 4 inches diameter. Rough and ready ramps of round logs were constructed for both loading logs in trucks and also for unloading them at their destination. In place of costly cranes and locomotives a superannuated elephant "Hariel Pershad" was trained to load trucks, to transport a train of logs and to unload at destination. This became so successful that soon all such elephants and all those that were fast becoming past work were brought into use for this work. Each elephant transported twenty-five tons of timber per trip and did two such trips per day over a length of two to three miles, doing its own loading and unloading. The gradient was level in some places, otherwise it was downhill the whole way. On spur lines where steeper gradients could be obtained (1 in 150) loaded trucks were worked by gravity. The monthly output over

this line was 1,200—1,500 tons and 10 elephants were employed to yard logs to rail.

Details of cost of extraction up to forest ships are as shown below:

		Rs.	a.	p.	
1.	Felling, bucking includes 10% depreciation of tools ..	0	6	5	per ton
2.	Dragging to rail includes cost of drag-paths, feed and upkeep of elephants and 10% depreciation of tools ..	0	10	3	,,
3.	Cost of tramline transport includes loading, unloading, oiling trucks, etc.	0	3	9	,,
4.	Cost of tramline construction ..	0	7	0	,,
5.	Rafting to the ship ..	0	2	4	,,
6.	Pay of executive staff ..	0	2	0	,,
7.	5% depreciation of rails trucks at 7,000 per mile ..	0	4	8	,,
		2	4	5	,,

as against Rs. 5-12-0 paid to the contractors for only coastal timber.

The Inspector-General of Forests in his "Note on a tour of Inspection in the forests of the Andaman Islands, 1936," remarks: "The tramway is being pulled by a superannuated elephant who seems to enjoy the work. He is in excellent condition and it is obvious that he is not being overworked. The tramway and the corrugated drag-paths have no reverse grade, the logs are loaded at the head of the tramway and unloaded at destination by the tramway elephant on to a sloping platform from where they roll down into the creek and are tied into rafts. This work is being far better done and at a cheaper cost than by any mechanical agency. The Andamans have tried American lumbering methods with the result that we have now Rs. 50,000 of worthless machinery. Various provinces of India have also bitter experience of so-called progress."

The Rangat tramline has conclusively proved that this is the best solution so far known for extraction of timber in the Andaman Islands. Coastal areas have all been worked out and unless a bid

for the interior areas is now made, the forest activities will have to be closed completely. Therefore, tramline construction on a large scale is now undertaken. Rangat-Betapur line, 15 miles, and Lurujig line, 10 miles, are now under construction. The reconstruction of Wimberly-Gunj line, 5 miles, to transport timber from Shoal Bay necessitated by the shortage of craft is also under consideration. But the chief difficulty in the Andamans is labour, and when labour is available, funds are not available or when both are available stores are not available. Best results cannot therefore be obtained unless, as Mr. Pearce says, the local administrative officers are given wider powers and a free hand in order to run this big business enterprise on commercial lines and to purchase consumable stores direct up to a limit and to increase staff.

In this connection the writer's grateful thanks are due to Mr. Flewett for giving him all possible encouragement and facilities, to Mr. J. L. Harrison, then Forest Engineer in Coorg, now Deputy Conservator of Forests in Assam, for giving the writer an excellent coaching in forest engineering while under him for over 6 years dealing with exploitation schemes in Coorg, and to Mr. Joseph, Ranger, for carrying out the writer's instructions faithfully and conscientiously.

Water transport.—When timber operations were limited to the Settlement areas, logs were dragged by elephants or were carted by buffaloes to tidal creeks where they were tied into rafts and poled down to destination. But the real problem of water transport began in 1886 when forest activities were shifted to Shoal Bay.

In Shoal Bay creeks, the floaters and semi-floater logs were tied into rafts and the heavy sinkers 2—4 were lashed to the sides of the timber boats. With four such timber boats and 48 men, the first sea transport of logs in the Andamans began from Shoal Bay to Chatham, a distance of 4—12 miles of open sea frontage sheltered by Ritchies Archipelago.

The method of rafting found most successful was that 50—60 logs were tied, three abreast with chains to two cross beams, 12 feet long 4 inches × 4 inches section, from the heartwood of black

chuglam, each placed about two feet from either end of the logs. The chains 5/16 inch diameter were in lengths of 15 feet or more, according to the girth of the logs, with a wedge-shaped dog hook at either end. The logs were fastened to the cross beams with a round turn of the chain and the end of the chain after passing half round the other end was fastened to the logs by means of the dog hooks being driven into the log, one at the fore-end and the other at the after-end of the cross beam. Two 5 or 6 inch coir ropes were passed along the raft fastened to each cross beam and thence to the timber boat or a launch.

These rafts were poled down in shallow waters and were rowed across in deep water. Thus more than 4,000 logs were transported in the first year and it was found possible to do so throughout the year except when the sea was very rough. However this method was found to be very slow because of the sluggish nature of the rising and falling tide. Therefore a tug boat " Eileen," built at Calcutta Dockyard, was purchased in 1894 for Rs. 21,458.

" Eileen " could tow a raft of 50—60 logs over 10—15 miles per day but it was found to be a dangerous method in open sea and could not be relied upon as a permanent method of transport. In order to supply the fast expanding markets for the Andamans timber, a steam timber boat " Rosamond," overall length 173 feet, breadth 26 feet, draft 6 feet when not loaded and 9 feet when loaded, twin screw engines developing 350 indicated horse-power to carry 200 logs, was constructed in 1905 at a cost of Rs. 1,13,000. This, however, was badly damaged during launching and was after four years' service condemned and broken up. In her place a new ship of 500 (?) tons with steel hull, at an additional cost of Rs. 94,746 for the hull, was built at Kidderpore in 1910. This was very satisfactory and transported 9,000 tons in 58 trips the same year and normally 16,000 to 18,000 tons annually, at a cost of Rs. 3-7-1 per ton. This ship was the sole means of water transport from forest camps to Chatham until 1928. It was condemned as unseaworthy and sold in 1935 after a very useful service of 25 years.

The " Rosamond " gave a great impetus to the expansion of forest activities, and forest extraction camps were organised far away from headquarters usually where timber was easily available. From tide water timber in rafts was usually poled down alongside " Rosamond " by men living in timber boats. S. L. " Surmai," built at Kidderpore, was bought in 1920 for Rs. 1,77,317 to serve as Chief Forest Officer's touring boat. S. L. " Stewart," also built at Kidderpore, was bought the same year for Rs. 55,869.

These steam launches towed timber rafts to Chatham whenever " Rosamond " was laid up for any reason or when more timber than the " Rosamond " could handle had to be brought in. Six or seven motor boats also were built at a cost ranging from Rs. 2,500 to Rs. 5,000 for towing rafts from tidal water to the ships and also for inspection purposes.

At North Andaman, towage of rafts was becoming extremely difficult owing to the exposed nature of the coast during the greater part of the year. " Rosamond " could be little used here because the creeks are too shallow. Therefore the " Douglas," a shallow draft vessel 180 tons $6\frac{1}{2}$ feet aft draft when loaded and $5\frac{1}{2}$ feet when not loaded, was bought in 1930 for Rs. 2,09,110. Two steel barges, one in 1929 for Rs. 61,449 and the other in 1934 for Rs. 62,665, were also bought for transport of timber. Since "Rosamond" was scrapped and North Andaman Division was closed down " Douglas " is being used in South Andamans. " Surmai " is now also used almost exclusively for towing the steel barges and is rarely available for touring purposes.

Cost of water transport is now Rs. 6-3-0 per ton, but this includes a percentage of all overheads including pay of Chief Forest Officer, depreciation, etc.

The following water crafts are at present available :

" Douglas " (about 120 tons per trip), two steel barges (about 140 tons each per trip) with "Surmai" to tow them, S. L. " Stewart," S. L. " Eileen " and motor launch " Jarawa " to tow rafts when sea is calm, can hardly transport more than 30,000 tons of timber. The annual output is up to 57,000 tons according to market demands.

Another vessel like the "Douglas" or the "Rosamond" is necessary, but as this needs an immediate heavy initial capital outlay, the reconstruction of the Wimberly-Gunj tramline to transport timber from Shoal Bay, a much cheaper alternative, is now under consideration. Proposals are also made to transport all timber from Betapur Valley—the richest in the Andamans—to Stewart Sound, North Andaman, over a tramline along the east coast. The need for water craft will then be greatly reduced.

Saw Mills.—Before a forest division was formed in these islands, a small saw mill was in operation at Chatham and another at Garacherama cutting about 100 tons of timber per month mostly for use of the local Public Works Department and a small quantity for export purposes. These mills after transfers and retransfers were finally transferred to the Forest Department in 1912.

In 1905 hand sawing was attempted in the jungle to utilize the hollow or otherwise unsound *padauk* trees that are usually left at site.

In 1915 a second band mill was purchased for Rs. 1,41,930 from Java and was erected at Chatham. This mill consists of two circular rack bench breakdown saws and a number of rip and cut-off saw benches. Rope-driven overhead cranes handle logs and squares. A 350 h.p. steam engine supplies the required power. Its average outturn is 23 tons per day or 6,500 tons per annum. It is a very antiquated mill and needs a good deal of man-handling.

A complete new Clark Saw Mill was purchased in 1927 at a bargain price of Rs. 1,27,600 from the Government of Burma, which had purchased it in 1920, but due to a change in policy never erected it. The erection of this mill in Chatham alongside the old mill was completed in 1929 at a cost of Rs. 31,607. It consists of up-to-date machinery, a chain log haul, log deck with stop and nigger 40 feet carriage, double inserted tooth, circular saw capable of sawing very large logs, a five-saw edger, a three-saw trimmer, a circular slab resaw, shingle saw and live and dead rolls. Its daily outturn is 28 tons and annual average is 8,200 tons of sawn materials. The cost of sawing per ton is Rs. 20-12-0.

An electric gantry was erected in 1929 at a cost of Rs. 65,377 to handle squares and scantlings in the yard. The electric plant also supplies light to all residential quarters of forest officers living in or near Chatham.

A band saw mill was purchased and erected in 1920 at a cost of Rs. 3,60,000 at Stewart Sound and was named Bonington Mill, in honour of Mr. Bonington, the first Divisional Forest Officer of North Andaman. Its average monthly outturn was 572½ tons and the highest was 945 tons in January 1928. This band mill was installed as an experiment to test the merits of the American Band Mill. The experiment, however, has not been a happy one and indeed has prejudiced the whole operations of the North Andaman Division. (F.A.A.R. 1928.)

This mill was closed in 1931 as a measure of retrenchment due to the depression in the timber trade and has not been reopened. Both the old and new mills in Chatham are now being worked to full capacity. The daily outturn of these two mills is 37 tons and the average annual outturn is 11,000 tons.

Yard Storage.—Scantlings and squares are completely under roof. Sawn materials are carefully stacked with sawn sticks between. Stacking of heavy squares is carried out by electric gantry and light scantlings by coolies. Transport within the yard and to the export ships is made by trucks on a system of well planned 2 feet gauge railway tracks. This great improvement of yard storage and yard transport is due to the indefatigable efforts of Mr. Flewett.

Markets.—The chief markets for Andaman timber are Calcutta, Madras, Rangoon and London. A small quantity is sold locally, mostly to the local Public Works Department and to the local match factory. Export of hardwoods is mainly in squares and scantlings and of softwoods in round logs for the match industry. The soft wood logs and hardwood squares are the mainstay of the finances of the department and contribute a large percentage of the net revenue. Mr. Mason in the Annual Forest Report for 1928-29 says : "The most remarkable feature of the year's working has been the

continued and rapid development of the trade in soft woods as a result of the establishment of the match industry in this country.

"Had this development occurred a few years earlier it is probably safe to say that the erection of the new mill with all the attendant cost and worries from the moment the log enters the mill to the time of the disposal of the output would not have been undertaken."

Calcutta is the largest purchaser of Andaman timber—10,679 tons in 1935. Sales were made for a time by tender and Messrs. Gillanders Arbuthnot, Messrs. Gladstone Wyllie & Co. and various others were the chief purchasers until the establishment, in 1918, of the sales Agency of Messrs. Martin & Co., a prominent firm in Calcutta. The tender system worked well and, in fact, immediately after the sole agency was given over, sales dropped considerably and only increased along with other Indian markets. The prices realised are lower than anywhere else, Calcutta being a highly competitive market. While feeling the way and getting Andaman timber established in the market the sales agency has served its purpose.

Madras is the next largest market—4,854 tons in 1935. In 1921 trial consignments of timber were made to Madras and Coconada and they were sold through the Agency of Messrs. Parry & Co. and the Coromandel Company. These agencies proved unsatisfactory. Direct sales to purchasers are now being made and the prices realised are about 25% higher than in Calcutta.

The most profitable market but difficult to please is London. This was the best market for Andaman timber in the early periods—8,700 tons in 1888 when Calcutta was taking only 2,600 tons, Madras 500 tons, Rangoon 20 tons. Strenuous efforts were made to develop it to its fullest extent. A sales agency was established in 1916. But its results were not up to expectations mostly due to want of facilities for shipping. Messrs. Howard Brothers & Co., the sales agents, gave up their agency in 1927, and the Timber Adviser to the High Commissioner in London is now handling sales. The exports in 1935 were 1,024 tons. Rangoon purchases only match wood logs—3,012 tons—and a small quantity of scantlings.

Most of the timber exported from the Andamans is being shipped by the SS. " Maharaja" running under Government Charter between Port Blair and the Indian ports.

Financial Results.—While the writer was coming out to the Andamans in 1929, one of the senior forest officers in India said that it was a prevalent belief that the Government of India had been sinking large sums of money into exploitation of the Andaman forests without adequate return and that the whole concern was now for sale for a " song." Whether this was due to the notice issued in 1923 calling for tenders to work these forests on a system of lease or whether, as Mr. Pearce says, it was due to the failure of forest accounts to differentiate between capital and revenue expenditure, the general belief was that money was being thrown away in the Andamans. Such, however, was not the case as is evident from the fact that the surplus from the earliest time 1869—1935 amounts to Rs. 64,68,205 and the deficits to Rs. 28,67,155. On 31st March 1935, the value of dead and live stock still in use, but after allowing adequate annual depreciation, was Rs. 16,56,269. Adding this amount to the net surplus of Rs. 36,01,050 this gives a net profit of Rs. 52,57,319 on the exploitation of these forests.

The most critical period in the history of the Andaman Forest Department was from 1919 to 1927—a period of deficits, the deficits amounting to Rs. 28,67,155. This period synchronises with the formation of the North Andaman division and the inauguration of a big development scheme involving a capital expenditure of Rs. 55,75,000. This was immediately after the war when prices for timber were high and there was a general rush for development entailing costly and ambitious schemes and experiments. These experiments in some cases proved a failure and in others before they could be completed the timber market collapsed causing great alarm and anxiety to those concerned. During this period of anxiety the Forest Department was exceedingly fortunate to have a series of distinguished members of the Indian Forest Service as Chief Forest Officers who were able to steer the department clear from a total wreck.

In addition to the cash surplus the Forest Department is saving the Government a large sum of money by maintaining a number of convicts and also by furnishing freight cargo for the ships chartered by the Government for mail service. The activities of the department also support numbers of the local free-born population.

THE MEASUREMENT OF SOIL EROSION AND RUN-OFF AN ATTEMPT AND SOME RESULTS

By R. Maclagan Gorrie, D. Sc.

Summary.—Examples are given of soil erosion and run-off data actually measured in the U. S. A.; the type of apparatus used in these experiments is described and some of the difficulties discussed. The first attempts at evolving a similar apparatus for Indian conditions are described. Data so far collected are given, but merely as an indication of the types of error which are to be expected. The Punjab Irrigation Research Institute has collected these figures while reducing the measurements to a standard routine, so that the next step, namely the measurement of erosion on various types of land, can be undertaken with some guarantee of precision.

We all know that soil loss occurs during each heavy rainstorm from most ground that is not adequately protected, and we also know that the rain naturally runs off more rapidly and more completely from steep slopes than from gentler slopes similarly covered. Foresters have always accepted such statements as truisms which are too obvious to argue about. These things are not so obvious, however, to " the man in the street " and in order to convince him, or rather " the man in the field," that this problem is a serious one, it is very desirable that we should have some figures to prove our statements. During a visit to America in 1934-35 I was very much struck by the close attention which was being paid by many research groups in different parts of the country to this phase of erosion control. Reliable figures had already been collected for agricultural crops during a period of 10-12 years from sets of long narrow run-off plots of a pattern which has been standardised for all Federal Experimental Farms. These plots are very narrow, measuring only about $6\frac{1}{2}$ feet across and $\frac{1}{100}$ acre in area, and there is one for each of the common local field crops and methods of cultivation. The entire rain run-off from each plot is caught in a huge vat and the clear water and sediment are separated and measured. The actual rainfall is carefully measured in rain-gauges, both of the ordinary type and by clock-work registra-

tion which gives the actual intensity of the rain as well as the total fall. The area of the plot × rainfall = the total precipitation, of which the catch in the vat is the percentage which has run-off, the balance having been absorbed by the ground and the vegetation. Similarly the amount of solid matter caught can be readily shown in terms of depth of soil removed from the surface.

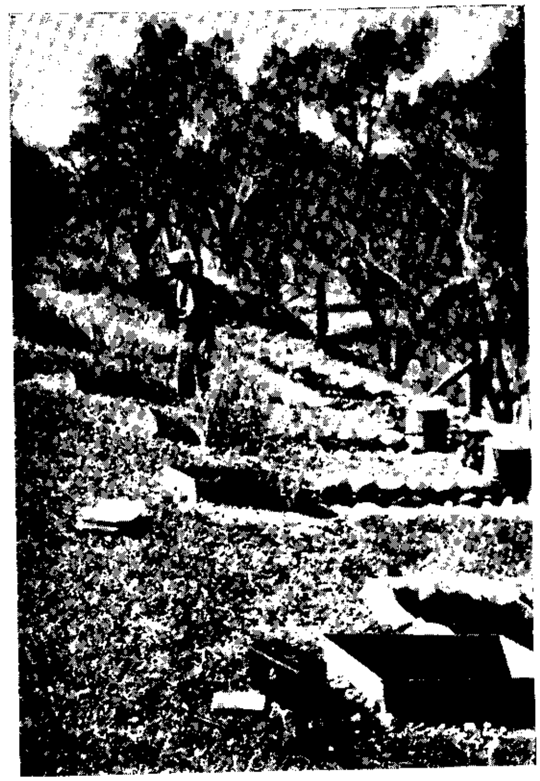
The type of measurements produced is well illustrated by the following table, which brings out very clearly the protective value of grass or any other dense crop which remains undisturbed for a large part of the year :

Location.	Soil.	Slope per cent.	Bare ground clear tilled.		Covered ground, grass crop.	
			Soil loss tons per acre.	Water loss per cent of precipitation.	Soil loss tons per acre.	Water loss per cent of precipitation.
Clarinda, Iowa ..	Silt loam	9·6	44·6	12·5	1·3	6·5
La Crosse, Wisconsin ..	Silt loam	16	59·9	19·2	0·003	2·9
Spur, Texas ..	Clay loam	2	6·1	12·8	1·6	5·8
Temple, Texas ..	Black clay	4	12	11·6	Nil	Nil
Statesville, N. Carolina ..	Clay loam	10	13·8	9·3	0·7	5·5
Pullman, Washington ..	Silt loam	30	31·2	29·8	0·4	0·3

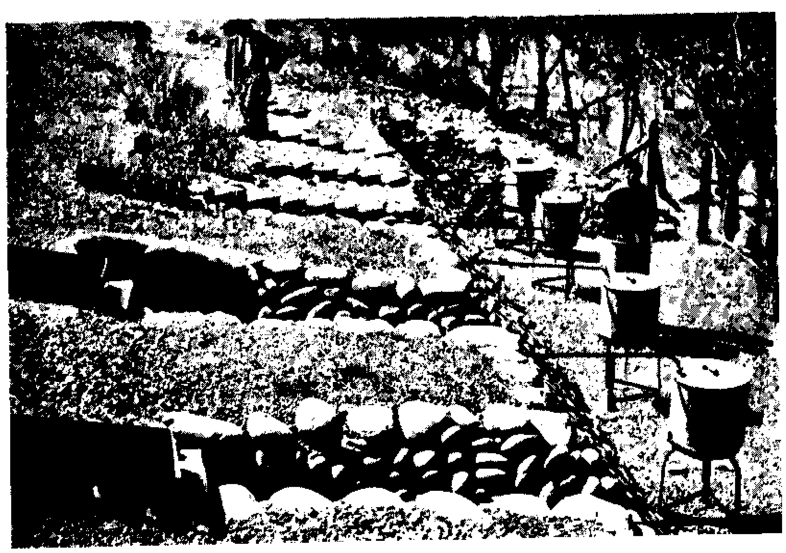
These plots are obviously fairly expensive to establish and require a special trained staff to look after them.

The measurement of erosion and run-off for American forest conditions had also been taken up by several of the forest experiment stations with considerably less funds for the purpose, and many ingenious " gadgets," such as tanks, trays, lysimeters and artificial rain throwers, were seen in the course of my tour. One of the simplest and most convincing was that used by H. G. Meginnis at a branch of the Southern Forest Experiment Station in the lower Mississippi valley. He had isolated a few square yards of ground under a forest canopy by means of a low wooden partition and caught the run-off from this plot in a dish in a pit.

The following schedule shows the type of data he has been able to produce :



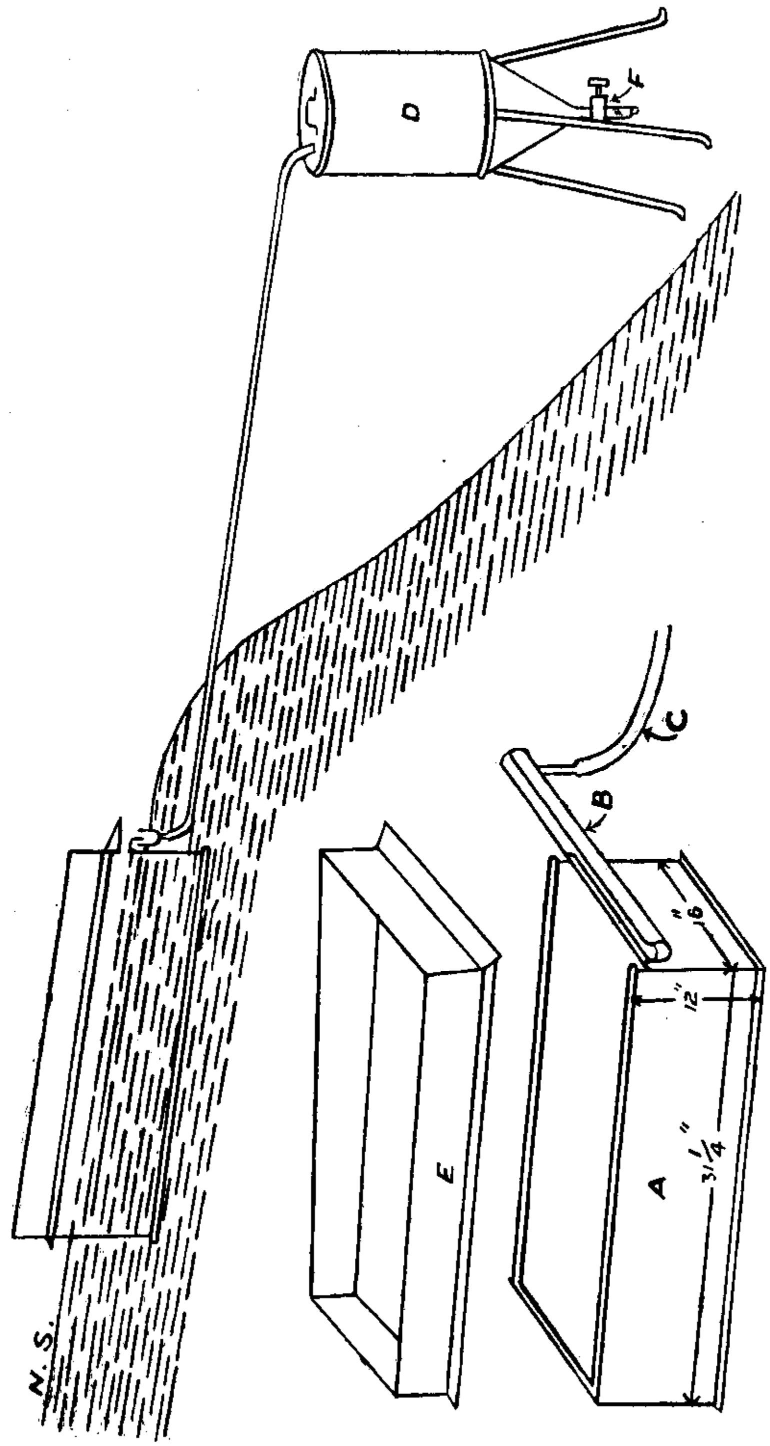
RUN-OFF TRAYS IN POSITION. THE NEAREST IS ONE OF A PAIR KEPT BARE BY SNIPPING AWAY ALL GRASS SPROUTS. THE FURTHER ONES SHOW A VARIETY OF GRASS AND HERB COVER



BATTERY OF SIX RUN-OFF TRAYS EACH ISOLATING A PIECE OF UNDISTURBED SURFACE SOIL. RUN-OFF IS CAUGHT IN A COVERED GUTTER AND LED THROUGH PIPE TO CONTAINER. CATCH OF WATER AND SEDIMENT IS MEASURED AFTER EACH STORM

Photos: R. M. Gorrie.

ARRANGEMENT OF FIELD APPARATUS FOR SOIL EROSION EXPERIMENTS.



(See DR. GORRIE'S EROSION NOTE.)

Run-off and Water Absorption for Loessial Soils, Holly Springs, Mississippi.

Plot.	Individual rain-storms.	Total precipi-tation.	Quantity of rainfall that was absorbed.		Soil lost per plot.	Relative quantity of soil eroded.	Rainfall required to erode 1 lb. per plot.
			Inches.	Per cent.			
	No.*	Inches.			lb.		inches.
Oak forest† ..	103	134	133	99	0·07	1	1789
Broomsedge, field (*Andropogon scoparius*)	103	126	125	99	0·30	4	415
Robinia and *Maclura* plantation	97	112	110	98	1·68	22	67
Bermuda grass (*Cynodon dactylon*) pasture ..	92	106	102	96	0·31	4	340
Scrub oak woodland ..	102	128	118	92	1·09	15	117
Barren abandoned land ‡ ..	103	129	68	52	236·96	3519	0·49
Cultivated cotton rows on contour ..	103	131	70	53	114·60	1528	1·15
Cultivated on slope ..	99	127	53	41	322·47	4300	0·39

*Difference shown due to the fact that in plots where exceptional conditions were seriously disturbed during certain rains, data were not taken for these rains.

†Run-off and erosion data based on average of duplicate plots for first six months of study.

‡Run-off and erosion data based on average of duplicate plots for first fourteen months of study.

(Copied H. G. Meginnis's Effect of Cover on Surface Run-off and Erosion Loessial Uplands of Mississippi.)

Although erosion was made a major subject in the Punjab Silvicultural Research programme a year ago, no extra staff was provided for this type of work and consequently no measurements could be attempted. We have, however, been fortunate in getting the co-operation of the Irrigation Research Institute of which the Director, Dr. E. MacKenzie Taylor, has already given our department valuable help in the analysis of hill forest soils. The following is an account of the first attempts made by his staff to construct and work a set of run-off tanks. These were prepared in the Irrigation Research workshop at Lahore to my rough specifications, and set up at the Upper Bari Doab headworks at Madhopur last July.

A previous investigation had been made by the Irrigation Research Institute statistical section to see if the discharge data and figures for total rainfall over the whole of the Ravi River catchment would give any indication of increased run-off percentage over a period of years, as a statistical proof of the generally recognised desiccation. This investigation showed that, unless the ratios of run-off to the total amount and the intensity of rainfall are worked out on a basis of exact measurements and combined with a detailed study of ground cover types, the river discharge and rainfall data for the whole of a large catchment will not yield sufficient evidence as to the progress of desiccation.

The chief difficulties in the use of any form of lysimeter tank or tray are—

(*a*) the trapping of the entire run-off from the plot. The catching arrangements must ensure that the whole run-off from the heaviest storm can be caught and measured, thus any plot larger than about a square yard of surface entails providing a very large catching vat or tub (A 7" rainfall on 1 square yard is 33 gallons and weighs nearly 5 maunds);

(*b*) the complete isolation of the plot from the surrounding ground to guarantee that only that rain is caught which falls upon the plot surface ;

(*c*) the question of herbage is difficult because a single bush or grass clump in a plot may grow beyond the plot edge and collect a considerable amount of rain from beyond the confines of the plot. A plot which contains many grass roots but is kept bare by clipping the grass shoots will give a higher porosity than a really plantless soil would give. A few stones in such a small surface make a very large difference to the porosity of the surface.

(*d*) even with careful cutting when the surround wall is put in, the soil edge is inevitably broken, so that the first few

storms will give irregular figures until these hollow edges become silted up;

(e) the effect of erosion is cumulative in the sense that most damage occurs towards the bottom of long slopes. In a square yard there is little accumulation of run-off and a bare plot tends to produce an " erosion pavement " of small stones which after a few storms increases the rapidity of the run-off of clear water but protects the soil from further serious washing.

The type of tray eventually produced after several experimental efforts is shown in Plate 62. It consists of a sheet metal surround wall A which encloses a horizontal surface measuring $16'' \times 31\frac{1}{4}''$, which gives 500 square inches, but this frame is made on a slant so as to enclose ground on a slope of 1 in 4. The bottom edge is provided with a lip which must lie exactly at the ground surface level, and below this in a small pit is a metal catch drain B which must be protected from the rain. From this drain the run-off is piped to a settling tank D which is fitted with a sloping bottom and tap so that it can be completely drained of water and sediment.

The drain is attached to the tray with two iron clips which fit into two holes in the top angle iron of the tray. Drain B empties itself into the leading pipe C, thence to reservoir D. The reservoir is placed at a lower level so that sufficient slope is given in B and C to ensure free flow of the run-off water.

In order to avoid interference by splashing from outside, a galvanised iron sheet is fitted to surround the tray. This sheet carries a flange which acts as a cover over drain B, so that no rain other than that which falls on the 500 square inch surface is led into reservoir D. Before the apparatus is installed all the trays, pipes, and the reservoir are tested for leakage. A rain-gauge is installed in the immediate vicinity of the trays.

To set up the apparatus the bottomless tray is placed on ground sloping at 1 in 4 and its boundary marked with a knife. The space

thus marked is covered with a metal cover the same size as the tray; the object of this cover is to protect the surface soil and plants *in situ* from being disturbed during digging. With the cover in position; the ground around is dug with a pick-axe to about the depth of the tray. The tray is now slipped down over this column of undisturbed soil and sunk until it sits flush with the surface. The trench is now filled in around it, and the drain B and pipe C placed in position. There should be no sharp angles in pipe C.

Six of these trays were put in on a slope of about 1 in 4 at Madhopur in June 1936 and every storm since has been measured. The site had to be at Madhopur as this was the only place where the Irrigation Research staff could carry out the work, but unfortunately the ground there consists entirely of boulder beaches of very large round river-borne stones set in a scanty matrix of soil, in fact the worst possible type of soil to yield regular results with this type of small tray. The data for a few sample storms are given in the following schedule. The six trays contained varying amounts of vegetation as shown in Plate 61 and the percentage cover is entered for each in the schedule. Roughly they formed 3 groups of 2 each, I and II being kept bare by frequent clipping of grass, III and IV being well clothed with a mixture of grasses and herbs and V and VI a sketchy cover of spear grass (*Andropogon contortus*) with a few small herbs.

In column 5 is given the intensity of rainfall per hour, but this has been worked out from the total rain measured and the period in which it fell. This does not give a true indication of the maximum intensity which may have actually occurred in the course of long-continued rain interspersed with heavier downpours. To obtain really accurate readings of intensity it is necessary to have a mechanical gauge which will register the intensity over short periods, but such gauges are very expensive.

Result of Madhopur Run-off and Erosion Measurements.

Date.	Vegetation.		Run-off Percentage.						Soil removed in lbs. per acre.					
	Rainfall in inches.	Intensity per hour	I* 5%	II 7%	III 90%	IV 75%	V 65%	VI 40%	I 5%	II 7%	III 90%	IV 75%	V 65%	VI 40%
4-7-36 ..	5·00	·50	40	36	69	48	47	52	6,964	4,022	4,582	2,500	5,850	9,061
12-7-36 ..	1·02	2·43	69	74	82	101	117	101	798	426	367	515	1,622	2,038
25-7-36 ..	·57	·13	19	15	2	11	21	36	186	164	108	27	166	171
27-7-36 ..	2·95	·56	50	50	50	81	49	105	1,040	1,156	114	284	1,134	1,306
5-8-36 ..	1·32	1·43	72	43	75	44	77	73	698	594	531	376	854	1,132
14-8-36 ..	1·40	·40	29	14	20	10	31	44	191	140	61	93	313	245
22/23-8-36 ..	11·17	·30	37	46	47	28	37	53	1,449	2,259	866	207	452	1,014
3-9-36 ..	4·70	·78	12	29	36	11	20	33	92	115	248	128	139	405
17-12-36 ..	·66	·08	12	12	9	4	11	9	18	63	6	29	30	19
14-1-37 ..	·79	·52	58	65	43	36	56	66	3,146	2,456	137	250	192	487
9-2-37 ..	·18	·03	10	11	9	2	3	3			No Erosion			
11/12-2-37 ..	·65	·03	Nil	1	Nil	Nil	Nil	1			No Erosion			
8/9-3-37 ..	·95	·08	7	7	4	1	3	10			No Erosion			

* Plot number and percentage of plant cover.

It will be seen that there are many anomalies in the results so far obtained, as might be expected from the foregoing discussion. Several points do, however, stand out clearly :

1. When the rainfall is very small, say 0·10 inch or less, the run-off depends upon the initial moisture content of the soil. If the ground is dry there may be no run-off at all.

2. The percentage run-off depends more on the intensity of fall than on the total quantity, the highest percentage being at a time when the intensity was also at a maximum.

3. Some trays show a run-off higher than 100 per cent. This is due to shrubs or tall grass outgrowing the size of the tray and leaning outside, thus catching rain from beyond the perimeter of the tray. As the error is not large, these figures have been allowed to remain, but they give a wrong impression of the value of plant cover in reducing run-off.

4. The *maximum erosion* was recorded with the heaviest rainfall and varied from 4,000 to 9,000 lbs. per acre, the worst figures being given by the poorly covered plots in the earlier storms. The formation of an " erosion pavement " of small stones has reduced the soil loss figures from poorly covered plots in the later storms.

5. When the vegetation cover is well established and sufficiently thick, it reduces the amount of erosion perceptibly, and conversely the removal of vegetation by clipping leads to continued heavy erosion.

I acknowledge with grateful thanks the great amount of time and trouble which this work has entailed for Dr. Mackenzie Taylor and his staff in the Irrigation Research Institute. The methods of setting up these trays and of measuring the run-off have been reduced to more or less a standardised routine, so that the next step, namely the measurement of erosion on various types of forest and grass-land, can be undertaken with some guarantee of precision.

THE BALSAN STATE FORESTS

By N. G. Pring, I.F.S.

Summary.—Commencing with a general survey of the forests and their history this note deals particularly with the 1927 working plan by H. M. Glover, to whom the writer is indebted for his collaboration.

The plan, which is the first of a type evolved as the result of experience under the Kulu plan (Trevor 1919), prescribes a system of irregular shelterwood.

The Balsan working plan has worked most sucessfully and has served as the model for a number of high hill forest plans.

The Balsan State, with an area of 52 square miles, and a population of 8,000, is situated in the Punjab Himalaya on the left bank of the Giri, 12 to 20 miles east of Simla. The demarcated forests, 10,619 acres or 33 per cent of the total area of the State, cover the higher slopes at an elevation of 5,500 to 9,900 feet and form a continuous belt between and above cultivation. The northern block, including nearly half the total demarcated forests, is drained by several perennial streams flowing direct to the Giri. The basin of the Chhotu nullah, an important tributary of the Giri, includes the remainder except for two small compartments situated in the southern portion of the State above the Bashari nullah. The soil is a clayey loam admirably suited to tree growth, and the gradients are moderate to steep and occasionally precipitous on the southern and western slopes. The climate at Ghorna, the capital, 6,000′, resembles that of Simla, where the average annual rainfall is 65 inches, more than half of which falls during the period July to September. Within the forest belt there is undoubtedly an increase in rainfall and distribution: along the eastern boundary, which forms the Giri Pundar water-shed, the average annual rainfall probably reaches 80 inches and snow usually lies for several months in the fir forests. The Balsan State with its numerous perennial streams affords an excellent example of an efficient catchment in marked contrast to the country opposite on the right bank of the Giri.

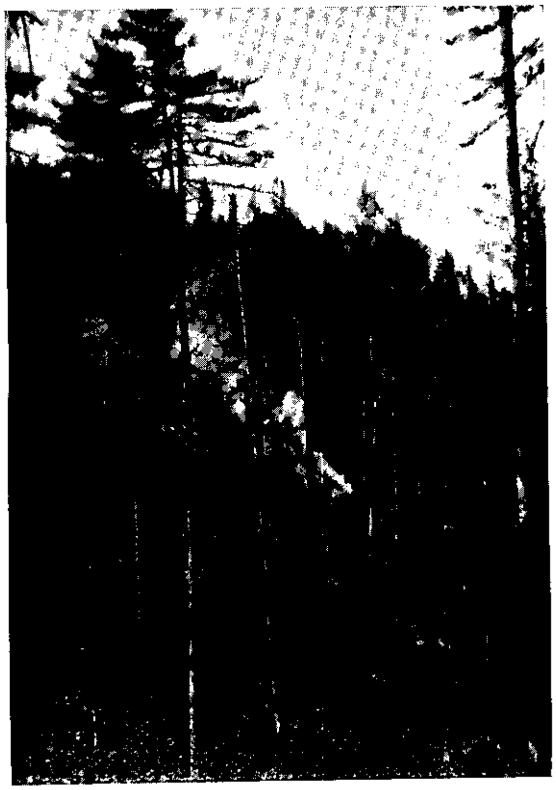
The high level forest includes about 4,000 acres of typical spruce, silver fir and karsu oak forest together with bird cherry, horsechestnut poplar, walnut and maple. Lower down and on warm aspects this type merges into mixtures of spruce, deodar and kail, and passes into

the kail, deodar, mohru oak zone, where kail forest predominates over some 4,000 acres and deodar over about 2,500 acres. Owing to lopping much of the kail is infested with the fungus *Trametes pini* which greatly reduces its value. Lopping of kail in demarcated forests has now been stopped throughout the State. On northerly aspects kail predominates at higher elevations and deodar at lower, but mixtures by groups are common. There is ample evidence of a continuous succession from kail to deodar, which is due in large part to selection management whereby light conditions are more favourable to deodar, assisted by light cattle grazing.

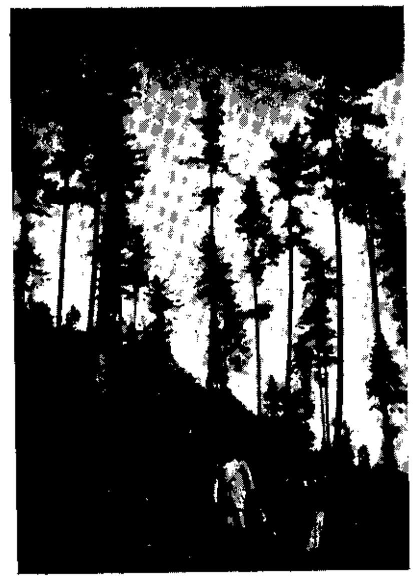
Below the demarcated forests and mingled with cultivation are several thousand acres of village undemarcated forest, mainly of the deodar, kail and mohru oak type. These forests are more than sufficient for the timber requirements of villagers, and the valuable grazing they afford reduces the incidence of grazing in demarcated forest to reasonable proportions. Village lands contain fine walnut, mulberry and apricot trees, besides which there are many oak spinneys well managed on a system of rotational lopping.

The grazing of sheep and goats is confined mainly to areas outside the forest and grazing of cattle is not excessive, in marked contrast to many less favoured localities. Fires are of infrequent occurrence and in 1921, when a wave of incendiarism coincided with an exceptional drought, less damage occurred in Balsan than in most of the surrounding States. The comparative fire immunity is primarily due to an adequate satisfaction of rights, resulting in a contented peasantry and the fact that belts of non-inflammable deodar and oak forest separate many of the highly inflammable kail forests from village lands, while the effect of light cattle grazing has been the reduction of inflammable grass and herbage with the result that ground fires are easily extinguished and do but little harm to the tree crop.

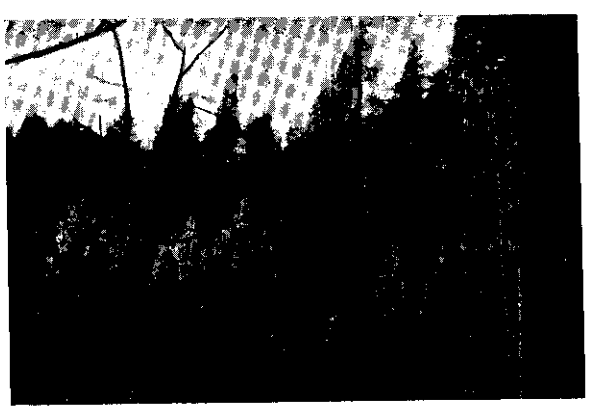
There are no local timber markets and all the produce is sold standing and floated down the river for sale at Abdullapur on the Jumna.



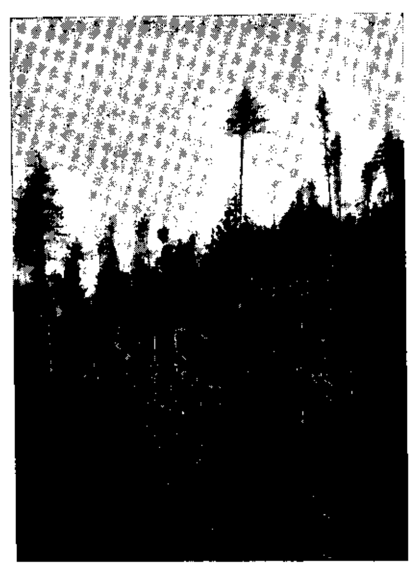
SLASH BURNING AFTER SEEDING FELLING



REGENERATION FOLLOWS SEEDING FELLING



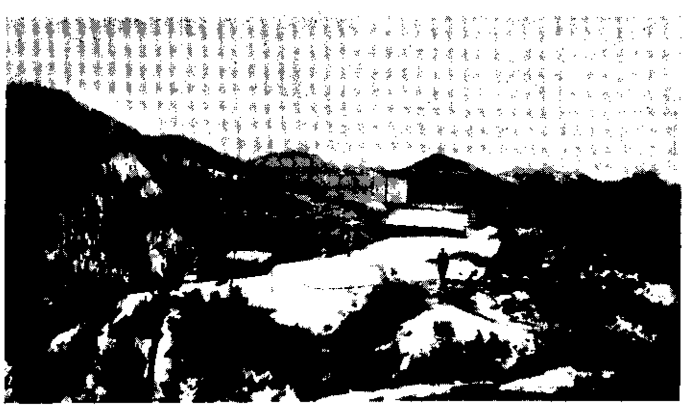
FINAL FELLING COMPLETE: NOTE THE IRREGULARITY



REGENERATION COMPLETE: OVERWOOD LEFT FOR INCREMENT

THE LATE RULER, RANA ATTAR SINGH

THE RULER, RANA RAU BAHADUR SINGH



A TYPICAL VILLAGE

A VILLAGER

The 1927 plan contains volume tables for deodar and kail which show that the locality is of high II Kulu quality and that Balsan deodar is approximately 0·8 standard I class quality as compared with *Indian Forest Records*, Vol. XII, Part VI, Howard.

The Rana is the owner of all waste and forest land in the State subject to rights of user in favour of local agriculturists. The forests play an important role in the economy of the State inasmuch as since 1887 they have afforded by far the greatest portion of the total State revenue. Previous to the introduction of systematic forest management heavy over-felling occurred between 1887 and 1890, when nearly all available large deodar were exploited and the capital value of the forests was greatly reduced. The first working plan was that of 1903 (E. M. Coventry) which prescribed the annual removal of 130 deodar and 700 kail of over 24″ in diameter. A few forests only were prescribed for thinning, but nothing was done before 1917. Between 1917 and 1924 a few forests were thinned and between 1924 and 1926 most of the forests were thinned heavily. The prescriptions were probably exceeded and expenditure on works of improvement was curtailed. The annual average surplus between 1911 and 1926 was Rs. 13,800.

When comparing the 1903 and 1926 enumeration statements allowances must be made for the fact that additional areas were demarcated and enumerated in 1926. It appears, however, that there was a slight increase of I and II class trees in spite of excess fellings in 1922 when 500 large deodar and 3,500 large kail, killed by fire in 1921, were removed. Except for the 1921 burns the forests were generally fully stocked. In the kail-deodar zone, there was still a deficiency of older age classes and a large excess in areas occupied by young woods.

The 1927 *working plan* (Glover) laid down the usual general objects of management, sustained yield, the production of trees large enough to yield B. G. sleepers and the satisfaction of right-holders'

requirements, etc., and allotted the forests to three working circles as follows :

The Regular Working Circle for the deodar and kail forests, area 6,376 acres.

The Afforestation Circle, area 267 acres.

The Fir Working Circle, 3,852 acres.

The Afforestation Circle has been completely restocked. Deodar was sown and planted and abundant natural regeneration of kail, spruce, deodar, poplar, and other broad-leaved species has resulted from 10 years strict closure. The whole area has been well tended. Deodar now occurs extensively over the lower half and in groups in the upper half of the median zone of the forests.

The Fir Working Circle, where the annual removal of 1,000 mature trees 30" and over is permitted should a demand arise, has not been worked as no reasonable offers have so far been made.

The Regular Working Circle.—The whole circle was enumerated and the results were as follows :

Diameter classes	III	II	I
Deodar	51,296	22,411	7,772
Kail	91,905	37,512	5,822

A nominal rotation of 120 years was adopted. The allotment to periodic blocks was as follows :

	P. B. I.	*P. B. II.*	*P. B. III and IV.*	*Total.*
Acres	1,397	1,443	3,536	6,376

Deodar and kail seed prolifically, regeneration is abundant, and in 1926 was so far advanced that it was decided to remove the overwood in two operations and to complete the regeneration of P. B. I in 15 years. An estimate of the final yield of deodar, which consisted of the volume of I and II class trees in P. B. I plus mature trees in other periodic blocks, was made, and this yield was compared with that based on the enumerated stock of mature trees in the whole working circle and on the rate of their replacement by II class trees. No additional yield to account for increment was taken, and an allowance was made for II class trees occurring in compact groups of poles retained to form part of the future crop. The essential basis of the

calculation of the final yield was thus the comparison and check between the yield known to be available silviculturally and that based on a mathematical calculation of the movements of the growing stock. The intermediate yield, consisting of deodar trees below 18″ diameter in P. B. I and immature trees in other periodic blocks was controlled by silvicultural prescriptions, and a thinning programme was based on area, and was not subject to volume check. The final yield of kail most of which was diseased, was the total volume of I and II class trees in P. B. I, not inclusive of increment. The annual final yields, as above defined, were deodar 34,000 c.ft.; kail 60,000 c.ft.

The working of the plan.—The first two years' fellings were far too light being marked by an inexperienced hand contrary to the wishes of the State Forest Officer. The State complained, the whole of the northern block except Shirgal II was re-marked, fellings were completed and debris was burnt in time for the 1930 bumper deodar seed year of which the State took fullest advantage. One compartment, Shirgal II, should have been felled in 1931 but was postponed by the D. F. O., owing to the very strict Circle orders regarding grazing and closures.

By 1934, when fellings had reached large kail blocks, two results were evident:

Firstly, that fellings could no longer proceed on the basis of a separate yield for deodar and kail; and

Secondly, that the kail yield would have to be increased or else a heavy area lag would result. The necessity of combining the yield lies in the fact that deodar is preferred as a seed-bearer in mixed forest and there is, rightly, a tendency to avoid felling healthy II class deodar wherever they can be left as a pole crop or when they can serve as seed-bearers. Also a proportion of the deodar is found in irregular forest on steep ground from which II class trees cannot normally be removed. The necessity for increasing the kail yield to avoid area lag lies partly in the fact that it is silviculturally necessary to remove in the first felling more than 50 per cent. of the standing volume in many areas and partly to the passage of trees from III to II and from II to I class dimensions, which gives rise to a very heavy

increment. This is best shown by Shirgal, compartment II, not worked along with other P. B. I.s of the northern block, where results of enumerations are as follows :

		I.	II.	III.
1926 Kail	..	63	440	737
1937 Kail	..	151	675	..
		+88	+235	

Khadharan, a kail forest of rather better quality than Shirgal, included the following stock at the time of enumeration in 1926 :

		I.	II.	III.
Kail	..	145	3,786	7,299

Considering that every III class tree passing into II class attains a volume of 60 c.ft. and every II class passing into I class increases its volume by 40 c.ft. it is not surprising that eight years later when the forest was marked for heavy seeding fellings, more than the volume enumerated in 1926 was removed. Khadharan is perhaps an extreme case, because there are few kail pole crops worth retaining, the forest is situated on easy northerly slopes and heavy fellings were indicated. In 1934, Mr. Glover visited the State, sanctioned excess fellings of kail up to 2 lacs c.ft. and advised a rather heavier type of felling in seeding felling areas so as to take the fullest opportunity of burning after seeding fellings as much debris as possible, especially in diseased kail units where the conversion losses are very high. Subsequently refresher fellings were made in some units, but even without these it was then obvious that, unless the total combined yield was increased, an area lag could not be avoided. It was felt that, while some increase was justified because the less valuable kail was being taken and the more valuable deodar retained, there was no need to depart from volume control and rush things on an area basis so as to repeat two felling cycles over all P. B. I.s in 15 years. After all, full regeneration is obtained as the result of seeding fellings, and provided these are of sufficient intensity, there is no need to hurry about removing the overwood.

The position up to date after 11 years is as follows:

		Deodar volume in c.ft.	Kail volume in c.ft.	Combined yields.
Actual	..	233,400	848,400	1,080,800
Deviation	..	*—140,600*	*+188,400*	*+47,800*

For the remaining four years of the period first-cycle fellings will operate in three small P. B. I.s where kail predominates, and the last year will include second-cycle fellings in the two forests first felled over. It is certain that there will be a further deficit of deodar and a slight increase in the excess of kail so that at the end of the period a deficit of approximately 200,000 c.ft. of deodar will be balanced by an excess of about 200,000 c.ft. of kail. As there will be a very valuable overwood and as there is a considerable area of pole crop left in P. B. I, the position as regards yield is most satisfactory. It is not possible to predict exactly the yield to be taken from a given area according to given silvicultural prescriptions in a given time, particularly when dealing with mixed and rather irregular woods where an unknown area of pole crop is retainable. In this case, by not allowing for increment and thereby underestimating the yield, the timing is out and there is a considerable area lag.

A survey of regeneration shows excellent progress. It must be borne in mind that nearly two-thirds of P. B. I is covered by pole crops retained or by advance growth. In the area under seeding felling, regeneration has been ensured by debris-burning, deodar-sowing or planting and by closure, which has resulted in adequate kail, deodar and spruce regeneration. In three small areas, near villages, aggregating about 50 acres, which were not fenced, regeneration is unsatisfactory. These have been fenced and nurseries are being raised. Deodar nurseries are also being formed now to ensure that the remaining seeding areas are restocked without delay. Apart from the ensurance of regeneration it is essential to give deodar a good start against kail, which must be treated as a weed where it suppresses or threatens to suppress healthy deodar. To grow deodar and kail in mixture it is estimated that deodar needs a six-year start. All sapling crops in the northern block of P. B. I have been adequately

thinned and the produce removed free of charge by villagers which has materially reduced the risk from fire. A regeneration survey shows that regeneration is up to date and that the proportion of deodar is materially increased. Burns outside P. B. I have also been restocked in the same manner.

Thinnings passed over all non-P. B. I areas as prescribed during the first ten years of the plan. Thinning produce has to be sold along with main fellings, and therefore owing to the area lag the second cycle of thinnings will be increased to an average of 12 or 13 years. This is probably an advantage because all non-P. B. I woods have been thinned at least twice since 1917. The State forest officer, B. Pritam Das, who is an expert at thinning, favours moderately heavy crown grade thinnings where feasible. P. B. II areas have been heavily thinned. B. Pritam Das is of opinion that thinning in the young pole stage should be kept light enough for the production of clean timber for which much higher prices are obtained.

Fire is still a great danger, and although no fires have occurred since 1921 it cannot be assumed that they will not recur. Recently the State have made over five miles of contour path and these are being continued so as to run through all P. B. I.s. Apart from facilitating inspection these contour paths serve a most valuable purpose by enabling the forest staff and villagers to reach vital points quickly in case of fire. Combined with, say, six lines of pure deodar below them on ground suitable to deodar, and broad-leaved trees such as walnut and horse-chestnut in nullahs and on damp localities unsuited to deodar, these paths serve as very efficient checks to fire and enable the staff to work with a large degree of safety.

Revenue.—The annual net revenue from the forests has exceeded the working plan estimate during the past ten years in spite of the fact that this period includes the years of world economic crisis during which timber slumped. The forest estate, including the fir forests has afforded a net profit of well over Rs. 2 per acre. As the fir forests have not been worked during the present plan, the profits have been derived from the kail-deodar forests which show a return of nearly

Rs. 4 per acre. In fact Balsan has one of the most valuable forest estates in the Punjab Himalaya.

Hitherto the gods have been kind, and there has been no severe drought or bad fire since 1921 but from now onwards it will be highly advisable to spend liberally on nurseries, roads and contour paths, etc., as an insurance against the future.

General.—At the end of the period P. B. I will contain pole crops up to 70 years old, sapling pole crops up to 30 years old and regeneration under an open but very valuable overwood some of which can be retained for the rotation. The true rotation is more than 120 years because of the pole crops and overwood left in P. B. I; it is probably about 140 years. As a greater proportion of deodar is retained for seed-bearers or second rotation overwood the rotation for deodar is greater than that for kail. The result is something more irregular than Femelschlagbetrieb. Regular circle is certainly a misnomer, and some object to the name "Punjab Shelterwood system;" but what is in a name, anyhow—call it Irregular Shelterwood system if you will. The general term "Himalayan system" is applicable. Under the Himalayan system a period of selection fellings is followed by a period of management of concentrated regeneration. This is actually happening in a number of our Himalayan forests. A period of management under a shelterwood plan which has restored the normal proportion of regeneration which had previously been lacking may, once that normality has been attained, be followed by management for a number of years under selection principles. It is by no means essential that a system, once adopted should be followed blindly at successive revisions of the plan.

P. B. II and portions of P. B. III and IV contain many woods similar to P. B. I but the proportion of deodar is higher. Another 30 years' work on similar lines would still result in considerable irregularity. Provided the stock of overwood left in P. B. I at the end of the period be not rapidly removed, it should be quite feasible to return after a further full period to selection management. The present plan has succeeded admirably in combining the advantages of the regular and selection systems. On the one hand predominantly

diseased kail woods are fully regenerated and the proportion of deodar is greatly increased. On the other hand considerable irregularity is maintained (surely an advantage in the Himalayas) and young woods are not sacrificed. Still greater irregularity could be ensured by retaining a large percentage of the stock of II class deodar trees in P. B. I; financially this would also be advantageous, because the sale price obtained for deodar of I class dimensions is so much greater than that for deodar of II class dimensions. For kail a similar modification would not be feasible because there are still large areas of diseased kail woods to be converted.

The revision is due by 1941 and, as the present plan is a definite success, the writer urges that the revision should continue on the same general lines.

Conclusion.—The basis of the working plan was sound, the success that has been was undoubtedly due to the intelligent practical application of sound silviculture forest principles by B. Pritam Das, the State forest officer. It is refreshing to find that sound principles of forestry have been followed in a State where the control is exercised only indirectly by Government. The present Rana, who is himself a trained forest officer, has inherited a tradition of sound forest management from his father, Rana Attar Singh, who for some years successfully undertook the duties of forest officer before he succeeded to the *gaddi.*

TWO YEARS OLD BAMBOO SEEDLING

By Saeed Ahmad, Forest Ranger, Hoshiarpur.

Dendrocalamus strictus seed was collected from R. F. Karnpur in May 1935 and was sown in July in a nursery with the break of the monsoon. It was extraordinary to find to-day a single seedling, among the whole lot in the nursery, flowering.

The history of this forest nowhere records a gregarious flowering to have occurred at any time. But it is possible that the seed from which this seedling had sprung up was collected off a completely flowered clump or perhaps a clump which had only a year left to complete its life cycle.

DENDROCALAMUS STRICTUS
ONE-YEAR-OLD SEEDLING IN NURSERY BED FLOWERING. HALDWANI RESEARCH NURSERY, U. P.
APRIL 1937.
Photo: M. V. Laurie.

Is it then a normal phenomenon that seed off completely flowered clumps will give forth seedlings which will flower with the beginning of their life and thus die, or is it merely an abnormality? If it is not a normal case, will it not be interesting to keep seed collected off completely flowered clumps separate from those obtained from partially flowered clumps at the time of sowings and watch the difference? What reasons can otherwise be attributed to this abnormality?

NOTE BY MR. M. V. LAURIE, I.F.S.

By a curious coincidence, I myself came across a case of even more precocious flowering of *Dendrocalamus strictus* a few weeks ago. A one-year old seedling was found flowering in a bed in Haldwani Forest Research Nursery (*vide* Plate 65).

Such cases of early flowering are rare. There are records of seedlings of 2 to 5 years flowering, and various theories such as bad soil, mutilation, etc., have been put forward to explain it, but as Troup remarks they must be regarded as " mere abnormalities."

Ranger Saeed Ahmad's suggested explanation that completely flowered clumps might produce offspring with a tendency to flower early is not a likely one. It is normal for complete clumps to flower, and most of the seed used in artificial regeneration is from such sources. It is abnormal, however, to see the young plants in a plantation flowering. I do not think that such precocious flowering can be explained in this way, nor is it more likely to occur in seed from either gregarious or sporadic flowering as far as we know.

Ranger Saeed Ahmad mentions an interesting point that is not generally known, namely, that during the whole of the known history of the working of bamboos at Hoshiarpur, some sixty years or more, no gregarious flowering has ever occurred. *Dendrocalamus strictus* appears to be more irregular in its flowering than most other species, but between 20 to 24 years seems to be the commonest period between flowerings. The Hoshiarpur bamboos have been regularly and methodically worked longer than any other departmental bamboos in India, and one begins to wonder whether this might possibly be a factor preventing wholesale gregarious flowering.

DESCRIPTION OF THE GOVERNMENT DEPOT AT KODIBAG

By D. S. KAIKINI, FOREST RANGER.

Summary.—The Government timber depot at Kodibag is the largest on the coast and was established in the sixties and stocks some of the finest teak timber from three Kanara Forest divisions, supplying the needs of Kathiawar and Bombay. Elephants play an important part in the operations.

The Kodibag Bundar is important for the traffic in timber as well as fuel from the coupes of the Fuel Reserves. Two years ago the traffic was so great that the creek was full of country craft and presented a picturesque appearance. This traffic has lately diminished as demand for fuel in Bombay has considerably fallen.

The annual export of timber and fuel from Kodibag aggregates Rs. 2,30,000 in value.

Kodibag is a small village at the mouth of the Kalinadi, two miles north of Karwar. It has a pier known as the MacDonald Pier built in 1880-81. The village is fairly important on account of the Government timber depot and timber trade in general. The occupation of the people there is rice cultivation, cocoanut palm gardening, fishing and running small passenger boats up the river as far as the navigable limit of 18 miles to Kadra.

The Government timber depot appears to have been established in the sixties. It was formerly managed by a Superintendent of gazetted rank and is now in charge of a forest subordinate of the Ranger's grade. The chief species stocked in this depot is teak.

The Kalinadi river starting from its source flows into the sea at this place after winding its way through a ravinous country which has fairly steep slopes bearing some of the finest teak areas. The teak-bearing areas are about 25 to 50 miles from the mouth of the river. Further down on its course deciduous and semi-evergreen types of forests rise high along both banks interspersed by long belts of cultivation between the banks and the forest. These forests are worked for the supply of firewood and small timber of species other than teak. Thus the river affords easy transport from the source to the exporting depot.

The supply of teak to this depot is from three Forest divisions—the Kanara Northern, Eastern, and Western. Gund is one of the finest teak-producing areas in Kanara Northern division and is situated about 46 miles south-east of Kodibag, Nersol is another such in Kanara Eastern division about 50 miles to the south-east and Dabbesal in Kanara Western division about 25 miles to the east.

Teak trees are either sold standing or the contract for extracting the logs and delivering at the Kodibag depot is given after calling for tenders.

Teak trees are girdled two years in advance of felling. Conversion into logs is completed by September and the logs are slid down the slopes to the riverside by elephants. In October all logs collected at the riverside are launched and floated down. The elephant plays an important part here. The river-bed is dotted with clusters of rocks all the way up to Kadra and the elephant guides all logs one by one from one pool of water into the next and so in this way the work progresses for one or two months. In cases of insufficient water in a pool, the water level is raised by putting two long logs across on the rocks and putting mats, twigs, etc., on the upper side of the stream to increase the flow of water and when sufficient logs are collected in this pool, a small narrow outlet is opened and logs are left into the next pool one by one. It is highly interesting to watch the elephant working in the river and any trouble taken to reach the place (for one has to pass through rugged country) is amply rewarded by the spectacle of the diligent work of the elephant.

When the logs are collected in Kadra the work of the elephant ceases. The logs are tied to each other with canes passed through the drag holes and a raft of 50 or 75 logs is made. These rafts are slowly and carefully brought by boatmen to Kodibag.

Here begins the work of the depot staff. The logs are dragged up from the pool and classified. The following general instructions for stacking are observed :

(*a*) all the logs are stacked into separate lots according to the lengths of—

8′ to 12′,
over 12′ to 18′,
,, 18′ to 25′,
,, 25′ to 30′,
,, 30′ to 35,′
,, 35′;

(b) in each lot, logs of more or less the same girth are stacked as far as possible. Should difficulties arise, the limit in girth may be exceeded by 6″ and in special cases by 12″;

(c) butt end is always placed on the pillow;

(d) all logs in one lot have one pillow;

The logs are classified and stacked as follows:

	Length.	¼ girth.	Remarks.
Selection class—			
(a)	.. 15′ to 20′	18″ and above	Sound and straight
(b)	.. over 20′ and under 25′	17″ ,, ,,	,, ,,
(c)	.. over 25′	16″ ,, ,,	,, ,,
1st class	.. 15′ and above	12″ ,, ,,	With 1 defect.
2nd ,,	.. 12′ ,, ,,	10½″,, ,,	With 2 defects.
3rd ,,	.. 8′ ,, ,,	10½″,, ,,	With more than 2 defects.

Up to 20 years ago the hauling up of logs from the pool and stacking in lots in the depot was being done by elephants. It is now done by men.

The depot can hold a maximum quantity of 12,000 *khandies* or 3,000 tons. In 1934 there were 2,250 tons and this year 1,625 tons are in stock of which 1,275 tons will be sold by auction in the third week of November.

The income of this depot is a lakh and a quarter annually.

The timber is mostly purchased by merchants from Cutch mandvi and a small quantity goes to Ratnagiri.

This is the biggest Government timber depot on the coast and supplies the needs of the Kathiawar State and until recently of Bombay.

A visit to the depot is a regular feature in the programmes of Governors while on a visit to Karwar. In November of 1932 and 1934 two visits were paid by the two Governors.

VIEW OF KODIBAG CREEK WITH A FLEET OF COUNTRY CRAFTS IN OCTOBER 1934
Photo : S. T. Nadkarni.

HAULING UP OF LOGS OF A CONTRACTOR BY HIS OWN ELEPHANT IN 1928

A SECTION OF THE GOVERNMENT TIMBER DEPOT SHOWING THE ARRANGEMENT OF STACKING TEAK LOGS
Photo : K. S. Wagh.

Kodibag is important from another point of view. The coupe contractors who purchase fuel coupes bring all their fuel to Kodibag for shipment to Bombay. In October 1934, the Kodibag creek was so full of country craft for loading firewood and teak logs that it presented an extremely delightful and gay look. In October 1936 it is the opposite picture. Very few *machwas* were seen loading fuel as the market for the same in Bombay is too discouraging. Prominent coupe contractors are now seriously thinking of manufacturing charcoal and giving up preparing fuel for the Bombay market.

The coupe contractors stock hardwood logs brought from their coupes in Kodibag in the river and sell them locally in the round or after conversion into scantlings.

Kodibag is thus a centre of activity in the timber trade in Karwar. Merchants from Goa, Ratnagiri and Cutch mandvi are seen frequenting during the fair season.

At the conclusion of the auction sales at the Government depot and on payment of the full purchase price, the logs are dragged down into the river and loaded into country craft for shipment to various destinations up to Cutch mandvi on the north coast.

The annual export from Kodibag is 3,000 tons of 50 c.ft. of timber, both Government and private, valued at Rs. $1\frac{1}{2}$ lakhs and 8,000 tons (1 ton = 100 c.ft. stack measurement) of firewood valued at Rs. 80,000.

REVIEWS

REPORT ON THE DEVELOPMENT OF THE CATTLE AND DAIRY INDUSTRIES OF INDIA

BY DR. NORMAN C. WRIGHT, 1937

Dr. Wright was engaged by the Government of India to visit India last cold weather to advise on the above subject. He has dealt with his problem in a most efficient and practical way and, having read every word of the publication, I would strongly recommend its perusal to all forest officers interested in this subject. To show the common-sense way in which Dr. Wright deals with his subject it is only necessary for me to quote the following passage :

> "It should be emphasised that the period during which there is any considerable growth of herbage on grazing lands is strictly limited ; for 3 to 4 months such lands can only be looked upon as exercise grounds, providing indeed an excellent training ground for young draught cattle, but no source of nourishment. In this connection I was struck by the almost universal demand of the villages for increased grazing land. I do not believe that the grant of such land would alleviate the present shortage of fodder, for the immediate tendency would be to overgraze the areas and leave them barren of herbage within a comparatively short period. Moreover, the provision of additional grazing

> land could not improve the food supply of the cattle during those months when drought prevents the growth of herbage. In any event grazing under Indian conditions cannot be looked upon as a source of nutrients for milking cattle."

This is exactly what forest officers have been saying for years and it is indeed gratifying to find that our views are supported by an authority of Dr. Wright's standing. It would be a good thing if the passage I have quoted was brought to the notice of every politician and every district officer in India. If every one of these would read the whole publication it would do something to remove the appalling ignorance which exists in this country on the management and feeding of dairy cattle.

C. G. T.

THE THREAT OF SAHARA

By E. P. Stebbing, Professor of Forestry, University of Edinburgh

The average person takes the Sahara Desert for granted as a component part of the globe, a blank area on the map which always has been and always will be there, like the Himalayas or the Black Sea. He rarely speculates on the origin of this vast desert or realises that it has developed in very recent geological times, and that its most rapid spread has taken place within recent history.

The Sahara is by no means all a flat sandy waste as is sometimes imagined. It has mountains running up to 10,000 feet and the relics of a large powerful river system that existed in quaternary times and which must have been fed by abundant precipitations. The geological and archæological evidence of prehistoric times shows fairly conclusively that much of it was then a humid region, well covered with forest. The climate has progressively become drier (as in many other parts of Africa), and a study of the probable causes of this progressive dessication is of the greatest interest to mankind, more especially, as the action of man himself has considerably hastened the spread of desert conditions particularly in recent times.

Professor Stebbing quotes a number of the best known authorities on the Sahara to show how parts of the Sahara once supporting a large population on what must have been fertile watered land are now dry, sandy desert. The ruins of large flourishing cities of Roman times in North Africa—Timgad, El Djim (Thysdrus) with an amphitheatre to hold 60,000 spectators, Gyptis (*Leptis magna*) and others—are now to be found in mid-desert, and the great empire of Ghana (9th to 11th centuries), believed to have been once situated in the midst of smiling fertile lands, is now one of the worst deserts in Mauretania. Recent history shows that the disappearance of vegetation is progressing more rapidly than ever before. As example, instances are quoted of patches of forest or estates that have been protected from the ravages of shifting cultivation and browsing by cattle, and now stand isolated in desert or semi-desert scrub surroundings, the change having taken place in the last 20 to 30 years. It has been estimated that the desert is advancing at the rate of about 1 kilometer per year on its southern edge.

The process of degradation of the remaining forests into savannah and finally desert conditions is described. Felling and burning the forest for shifting cultivation is the beginning, followed by grazing of large herds of goats and cattle, with its usual accompaniment of lopping the few remaining trees. The soil, after yielding crops for a few years, becomes impoverished and water supplies become scarcer. Cultivation ceases and savannah grasses take possession. Grazing eventually produces true savannah conditions which through the blowing in of sand in an ever thickening carpet gradually turn to desert. The process is irreversible and irrevocable, and reafforestation is impossible under these conditions.

That is the picture painted by Prof. Stebbing, but there are some critics who do not agree that it is altogether a true statement, no more than they agree with his implications that the dessication is primarily caused by the action of man. It appears that in some cases assumptions have been made on observations which are capable of more than one interpretation. For instance the disappearance of forest, though

primarily, no doubt, caused by the action of man, is also accelerated through the general dessication of climate that is taking place in Africa, a dessication that is not confined to the Sahara. Prof. Stebbing argues conversely that the dessication and sinking of the water levels are caused by the destruction of the forest and describes this as a " commonly held tenet of the forester." Alternately it may be argued that the dessication of the Sahara and its climate is due to some gradual general macro-climatic change, not dependent upon the existence or disappearance of tree growth. There are, however, many conflicting opinions on this point.

Another matter upon which there are differences of opinion is the irreversibility of the change of vegetative conditions. There are villages in northern French Uganda round which clearings have been made and apparent desert conditions created which are indistinguishable from the stages described by Prof. Stebbing. Some of these have been abandoned and scrub forest has gradually come back.

This pamphlet by Prof. Stebbing is worthy of wide circulation. Though containing some points which are open to controversy it gives much historical and observational evidence on the rôle man is playing in the rapid encroachment of the desert on the forests of Nigeria, and has lessons to teach that should be marked by anyone who has anything to do with determining land utilisation policies in tropical countries. The worst of it is that, even with the knowledge that we have of the effects of the destruction of forest and the creation of uninhabitable desert conditions by man's folly, effective action to stop the process is usually lacking. Remedial measures involving the eviction of populations from areas in danger, restrictions of grazing rights and of rights to forest produce, etc., are invariably unpopular, and it is rare that in a democratic country, even though full knowledge and expert advice is available, the politicians will risk such unpopularity for the ultimate good of the land. There may be something to be said for dictatorships in such cases.

M. V. L.

EXTRACTS

PORTABLE RADIO FOR U. S. FORESTRY SERVICE PLANNED

Portable radio equipment for forest rangers in the State of California—and other States—who travel in the back country is just around the corner.

Efficient use of this portable radio equipment in all phases of forest work, and particularly in fighting forest fires, has brought its value to a new height here, reports the office of the regional headquarters of the United States Forest Service.

Radio was used in emergencies many times last year where all other means of communication were cut off or either not available or so slow that loss of time would have meant large loss of valuable resources, according to a statement by Mr. S. B. Show, United States regional forester for California.

He gave several instances in which the use of the portable radio sets used by foresters were invaluable.

Radio, he said, however, will never supplant the telephone in the national forest, but he pointed out " radio will supplement the telephone service to give more effective protection and administration."

The radio as used in the forest in the case of forest fires, permits the fire boss to keep in contact directly with his men on the fire line, and enables those on the line to report quickly conditions requiring reinforcements and supplementary equipment.

Its most important uses as outlined by Mr. Show are : To contact work crews in isolated regions ; to communicate with CCC spike camps remote from the main camp ; to keep in touch with fire chiefs and other officers on observation trips where quick reports often prevent fires from spreading.

Radio equipment used by the Forest Service must be specialized, Mr. Show contends. The rough topography, deep canyons, peaks, and the cover of trees all necessitate something different from the regular instruments used outside the mountains and forests. Constant research and experimentation, he said, is being carried out to adapt the radio more accurately to the problem of forest conservation.

All forest equipment is being strained to the utmost at this time, and will be from now on, it is reported, to spot the forest fires as they occur for the purpose of preventing to a greater degree the destruction that has occurred in past years.

Again, as in years past, warnings are issued to all travellers, campers, hikers and motorists to take care with their matches and fires. It takes a forest fire only a short time to spread and spoil whole areas where it takes but a little care and thought to extinguish fires, matches and other inflammables that cause the fires.

The Christian Science Monitor, July 9th 1937.

HAS MAN A SENSE OF DIRECTION?

BY CALVIN RUTSTRUM

Men of the open for generations have vied with each other on that eternal subject, their sense of direction. A myriad tales have been told of the adventurous and uncanny feats attributed to this purported faculty. As far back as the fables of Egypt, these tales dot the perspective of literature and no less do they adorn the present

day narrative. Yet, always with the fundamental idea that only a chosen few have been gifted with that conative impulse which holds them unwavering to the straight and ever-orientated course.

Now, whatever our conclusions may be on this point, it would be unwise to question the veracity of these story-tellers in so far as the physical aspects of these feats are concerned, for they could, no doubt, have been accomplished either by minds attuned to keen observation, or by accidental circumstance. As to their performance through an instinctive sense of direction, we are immediately confronted with an insurmountable barrier of authoritative opposition.

Psychologists and physiologists unarbitrarily agree that man has no sense of direction. To the man of the forest this may not be a very romantic bit of news coming from the professorial circle, but, if true, it is nevertheless edifying. After a hard day in the woods, it might be well when returning to camp to know how much to depend on instinct, and how much to depend on sensible observation and the compass. There is a certain pleasure in living under illusions, but they are not at all conducive to our welfare when they affect our security, or apply to the extremely practical side of our lives. To confess—I have always been reluctant to acknowledge that secret consciousness of not possessing a sense of direction ; meanwhile living with a certain envy of others who claimed to be so endowed. Therefore, the eminents whose task it is to explore our minds have given me no little measure of encouragement by the result of their finding in this interesting field of research.

It is interesting to note how these men of science, in refutation, have arrived at their conclusions. Not long ago several psychologists conducted a very interesting experiment on a perfectly level stretch of prairie ground. A great number of persons took part—old patriarchs of the early West, young cowpunchers, business men, sportsmen, university students, and others—many who were alleged to possess a sense of direction.

A day was selected when no wind was blowing and the sky was overcast, so that the subjects should not be guided by the direction

of the wind nor the warmth of the sun on one part of the body or another. They were shown an object on the horizon, and while facing it were blindfolded, then asked to proceed toward it. Some walked, some ran, others drove cars ; all veered in a circle, and in their travels described something which looked like a spiral or a coil spring. As they proceeded, all were asked from time to time about their general direction and all were equally certain that they were continuing in a straight line. Later, when the experiment was transferred to the water—tests being made by swimming, canoeing, and rowing—the same results obtained. Without an exception they took to describing marine curves instead of straight lines.

There were some interesting disclosures. Even though all travelled in a circle, with now and then a short, straight spurt, the spirals varied from twenty feet to four hundred yards. In an attempt to account for this peculiarity in man's nature, it was proferred that the difference in length of one leg over the other and their variations in strength caused this veering. Leg measurements and tests were made to determine these differences and compared with the veering registered on the charts of the subjects. The result of this observation ran the leg theory into the ground, and it was finally concluded that it was not, as had been supposed, a matter of relative leg-strength or leg-length at all.

Moreover, it was not the result of being left-handed or right-handed. Tests exploded this tendered notion as well. Left-handed persons veered to both right and left, and likewise with right-handed persons. Many further presumed that it was a matter of muscles. This theory was quickly dissipated when a person was placed blindfolded beside a driver and asked to instruct the driver to turn either to the right or to the left, whenever it was felt that the car was not being held in a straight line of travel. Likewise in this case, curves and spirals were invariably the result.

The muscular theory and other physical attributions continued to lose value as further experiments were made. This was true when reversals and alternate action took place. Where the parties first walked forward for a while and then backward the same peculiar

circles and spirals were followed out; sometimes to the right and other times to the left with no apparent modification through any attributed muscular weakness. In the case of swimming where the subject first proceeded forward in the normal fashion, then on his back, or with the side stroke the circles continued. Whether in driving, walking, rowing, or swimming, the arcs in the charts of progress remained very much the same in size, except that the steady plodders described a slightly larger circle on the average than did those who were more impulsive in nature.

As manifested in other conditions of this kind, the explanation is not an easy one. Certain eminent physiologists believe that our tendency to describe a spiral when blindfolded is due to the nature of our nervous system. It may still remain a task for them to determine the real cause of this tendency toward the spiral; but for all practical purposes it has been quite well established that somewhere in the nerve system there is a spiralling mechanism. From observations made, it is not a matter of intelligence; and it would, therefore, be unwise to regard with disdain a guide who could not hold to the true course without the aid of his eyesight and the other senses. *The interesting point here is that the imbecile and the intelligent* man have shown in tests to describe the same spirals, when deprived of the use of their sight. An imbecile was taken from an asylum and blindfolded in the same manner as other subjects, with the resulting circumstance that the spirals were no less uniform than those described by sane individuals of high intelligence.

As an adjunct to the point in question, I might explain that the single-celled amoeba in its apparent groping, swims in this same circling style; a point which would probably have been of much interest to Darwin in showing a connection between the first form of life and man. This circling is also true of animal life in general when it is frightened and is running from an enemy.

Veterans of the wilderness who have read to this point will probably suspect pedantry in the foregoing allegations of the professors. This skepticism, if it exists, is not in a way irrational. My experience in the wilderness had thrown me with men for whom I

had the greatest respect concerning their " sense of direction, " and it was not an easy matter for me to amalgamate the reasoning and research of the professors with the faculties I had attributed to these men of the out-of-doors. Hovering between a half believed revelation in the instinctive character of man and an almost traditional respect for the ability of certain woodsmen, I decided to make concluding experiments which would decide the question one way or the other as far as I personally was concerned.

I had in mind, as one of the deciding factors, a friend whose travels from Ontario to Quebec have remained with me a symbol of fine woodsmanship. We regarded him as unexcelled in two things: he could make the finest bannock of any man in Canada and, when travelling, could find the shortest route between two points. Unfortunately, he had never obtained an academic education, but his knowledge of the woods was the envy of most men he came to know. Whatever my views are at this time concerning instinctive qualities, there is no question but that I believed my friend possessed a sense of direction. I had followed him through bog and timber when I was certain that he was as erratic as a chip in a maelstrom, only to find that we would suddenly come to our destination in a minimized length of time.

He was not a little offended when, one evening before a camp fire, I asked him if he had a sense of direction. This question had been prefaced with another, asking him how he got about the country so well. He balanced a small hot coal from the fire on a chip to light his pipe, and when it began to draw well, he said: " Well, b'y, it's sumthin' yu can't learn. If yu hain't got it yu hain't got it."

With as much diplomacy as I could conjure, I coaxed him into a test two days later when the lake was calm and the sky overcast. I pointed out a rocky abutment across the lake and asked him if he could paddle the canoe while blindfolded, and come within a reasonable distance of this abutment. I sat in the front seat and observed the result. Somehow I had a strong desire that he should win. The very traditions that had been handed down from father

to son seemed involved in the success of his venture. The canoe was pointed straight as an arrow at the rocky abutment; and with a folded bandanna tied over his eyes and around his head, my friend began to paddle.

I could see grim determination in the set of his mouth, as though an inner sense were adjusted to a straight course and should not for a moment be relaxed. Within two hundred feet from the start, the canoe began to veer to the left, then held a moderately straight course for fifty feet, after which it began to veer again to the left. By now, the rocky abutment was several points off the bow and I had a fear that the professors were right. It was not long before we were moving almost directly away from the general direction of the abutment. Meanwhile, I was attempting to draw the course on a sheet of paper, alternately scattering pieces of birchbark on the placid surface of the lake to mark the course. The graph looked something like a coiled spring that had been bent out of shape. Bill finally ran ashore about a half mile from the starting point—almost opposite from the direction of the abutment—and there pulled the handkerchief from his eyes. He looked a bit bewildered, then asked to see the chart of his travels. We gained a high rocky point where patches of birchbark could also be seen strewn about the lake. He sat down on a rock and laughed heartily for several minutes, even though he must have sensed a sharp disappointment. His rational resignation to fact when it was apparent is probably the fundamental reason for his superior ability as a woodsman. It is needless to show the subsequent tests which were carried out from time to time in my own personal endeavour to get at the truth of this peculiar phenomenon; but I might give the conclusion ultimately drawn. It is my opinion that man has no sense of direction in that he possesses a biological compass which holds him to a straight course. I must agree with the professors that something akin to a spiralling mechanism controls the individual in his travels. Unless he can use one or more of the senses as a relative guiding factor to something in his environment alien to himself, he is unable to hold to the straight line or move from one point to the other consistently.

Ability to travel a straight course, as claimed by many guides, is plainly the result of their observation. At the end of the day, they may not be able to call a single guiding unit; but, in their travels, they are, nevertheless, unconsciously projecting something ahead of them or moving in relation to some extraneous element in the landscape.

(*American Forests*, February 1936.)

THE LANTANA BUG, TELEONEMIA LANTANAE, DISTANT

BY R. V. FYFE, B.SC. AGR.

Assistant Research Officer, Division of Economic Entomology.

The Council for Scientific and Industrial Research introduced the lantana bug, *Teleonemia lantana* Dist., into Australia, at the end of 1935, to assist in the control of the lantana weed. This insect is a small plant-feeding bug belonging to the family Tingitidae. The bugs feed on the leaves, flowers, and young stems, by means of a beak which pierces the plant tissue and through which the contents of the plant cells are sucked. The feeding causes the death of the plant part attacked.

Tests have shown that the lantana bug cannot feed or develop on plants other than those belonging to the genus *lantana*.

At the present time, attempts are being made to establish *T. lantanae* in selected localities in Australia and on Norfolk Island, from stocks bred in the insectaries of the Division of Economic Entomology, Canberra.—*Journal of the Council for Scientific and Industrial Research, Vol.* 10, *August* 1937, *No.* 3.

[" The Forest Entomologist of the Forest Research Institute, Dehra Dun, is watching the results of these experiments with interest with a view to the possibility of introducing the lantana bug to India.—ED."]

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for September, 1937:

IMPORTS

ARTICLES	MONTH OF SEPTEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER Teakwood— Siam ..	201	14	136	19,006	1,747	15,983
French Indo-China ..	20	104	651	2,045	12,050	80,688
Burma ..	..	..	11,202	..	..	16,44,959
Other countries ..	..	76	501	..	10,185	64,515
Total ..	221	194	12,490	21,051	23,982	18,06,145
Other than Teak— Softwoods ..	1,280	946	499	72,850	58,281	33,540
Matchwoods ..	..	848	650	..	44,125	41,004
Unspecified (value) ..	..	..	..	1,06,575	43,601	2,26,347
Firewood ..	27	20	32	405	300	480
Sandalwood ..	..	26	34	..	7,778	5,045
Total value of Wood and Timber ..	..	..	..	1,79,830	1,54,085	3,06,416
Manufactures of Wood and Timber— Furniture and cabinet-ware ..		No data			No data	
Sleepers of Wood ..	..	..	78	..	..	15,593
Plywood ..	..	206	118	..	50,337	17,658
Other manufactures of wood (value) ..	..	..	..	2,09,072	90,814	1,25,963
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,09,072	1,41,151	1,59,214
Other Products of Wood and Timber— Wood pulp (cwt.) ..	15,302	12,199	15,129	96,941	86,076	1,22,471

EXPORTS

ARTICLES	MONTH OF SEPTEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	4,505	3,699	39	8,85,277	7,50,473	5,337
„ Germany ..	805	265	..	1,83,624	67,062	..
„ Iraq ..	160	38	..	27,803	6,798	60
„ Ceylon ..	62	109	..	7,770	13,508	46
„ Union of South Africa ..	470	782	..	75,693	1,67,650	..
„ Portuguese East Africa ..	256	181	..	43,800	31,296	..
„ United States of America ..	42	201	..	10,950	59,420	..
„ Other countries ..	741	365	73	1,33,975	85,090	19,738
Total ..	7,042	5,640	112	13,68,892	11,81,297	25,181
Teak keys (tons) ..	455	347	..	66,600	46,591	..
Hardwoods other than teak ..	271	195	7	27,849	19,354	1,700
Unspecified (value) ..	...	..	..	29,329	35,210	54,664
Total ..	726	542	7	1,23,778	1,01,155	56,364
Sandalwood—						
To United Kingdom ..	1	2	7	1,500	2,000	6,880
„ Japan ..	24	15	10	24,966	39,303	10,010
„ United States of America ..	136	50	100	1,37,920	50,000	1,00,000
„ Other countries ..	9	22	3	8,847	25,270	3,929
Total ..	170	89	120	1,73,260	1,17,573	1,20,819
Total value of Wood and Timber ..	..	..	..	16,65,930	14,00,025	2,02,364
Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	4,111	6,851	23,372
Other Products of Wood and Timber ..	No data			No data		